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# GEOGRAPHY OF MISSOURI

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# GEOGRAPHY OF MISSOURI.

Geography, like history, is never finished. As long as the people of Missouri adapt themselves in various way to their geographic environment, so long will the content of the geography of the state change. The object of this bulletin is to awaken interest in the geography of one of the most interesting states from a geographic point of view, and to increase the appreciation and study of the content of Missouri's geography.

The current idea of geography makes it the science that treats of the earth as the home of life including the distribution of things upon the earth's surface and the reasons for this distribution so far as they are controlled by earth factors. Looking at this concept of geopraphy, it is seen that there are two main factors, the inorganic and the organic, or, in other words, the physical and the life factors. For our purposes, the physical factors consist of the earth, its surface, drainage, rocks, minerals and soils; the air, its temperature, moisture and movements, or, in short, climate. The organic factors are the people of Missouri who have at different times and in various ways been influenced by their geographic environment. To take a concrete example which will be elaborated later, the Missouri River, a navigable stream, was a factor to which the settlers responded by using it for communication and by locating in a narrow zone along the river.

In taking up the geography of Missouri, the rocks of the state will be briefly described and then the surface and the factors which have produced the surface, and the soils will be discussed. These, together with the climate, constitute the inorganic side of the state's geography. The settlement and development of the state with especial reference to these factors will next be taken up.

## I.—ROCKS OF MISSOURI.

The Bed Rocks.—With the exception of a small area, most of the rocks in Missouri are sedimentary, that is, they were first deposited in water as mud or sand or gravel and subsequently hardened into rock. Evidences of this origin are found in several characteristics. The stratification by which many rocks are found in layers or strata is due to the sorting of materials by streams or currents. It is especially characteristic of shales and sandstones. Marine fossils are often found in sedimentary rocks. Ripple marks made at the bottom of shallow water, and sun cracks made by the drying of sand or mud are found in old rocks as well as in the sand

and mud along our streams, and indicate unquestionably the water-laid origin of the rocks.

The general sequence of the rocks in the state is shown in the section, Figure 1. Older rocks, underlie the younger. It should be remembered that this section is generalized and will not anywhere be found entire.

Most of the rocks of Missouri belong to the Paleozoic period. The oldest sedimentary rocks (Cambrian) were deposited on the old floor of pre-Cambrian igneous rocks which is for the most part deeply covered and reached only by a few deep wells. For most of this and several succeeding periods, the Mississippi basin adjacent to Missouri was for the most part a great sea in which the Cambrian, Ordovician, Silurian, Devonian and Mississippian rocks were deposited. The rocks of these periods are largely limestone, although locally there are considerable beds of shale and sandstone. From the geological map (Figure 2) it is seen that the Devonian is a thin, discontinuous bed of small importance. After the deposition of the Mississippian limestones, much of the region was elevated and the sea partly withdrew. The Pennsylvanian period was a time of oscillations. The lands were low and level, and slight changes of elevation altered the position of the shore line, now converting the region into land and again into swamps and shallow seas. The swamp conditions favored the accumulation of the coal measures whose origin will be briefly discussed in another chapter. The Pennsylvanian rocks are largely shale and sandstone with considerable limestone.

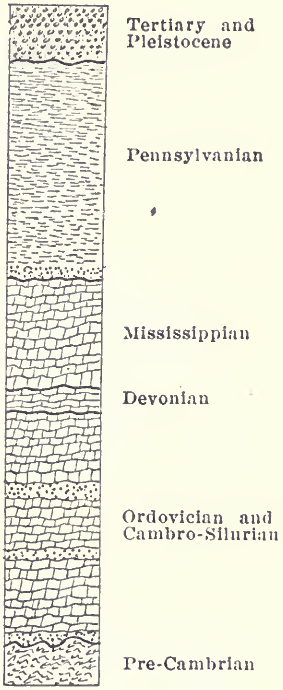

Fig. 1. Ideal geological section of Missouri. (after Marbut. (16a)

After the deposition of the Pennsylvanian rocks, most of Missouri was elevated and probably remained permanently above the sea. In the Tertiary period, which is relatively very recent, southeastern Missouri was at the northern end of an embayment which extended far southward and in this arm of the ocean the Tertiary sediments which now underlie the south-eastern lowlands, were de-

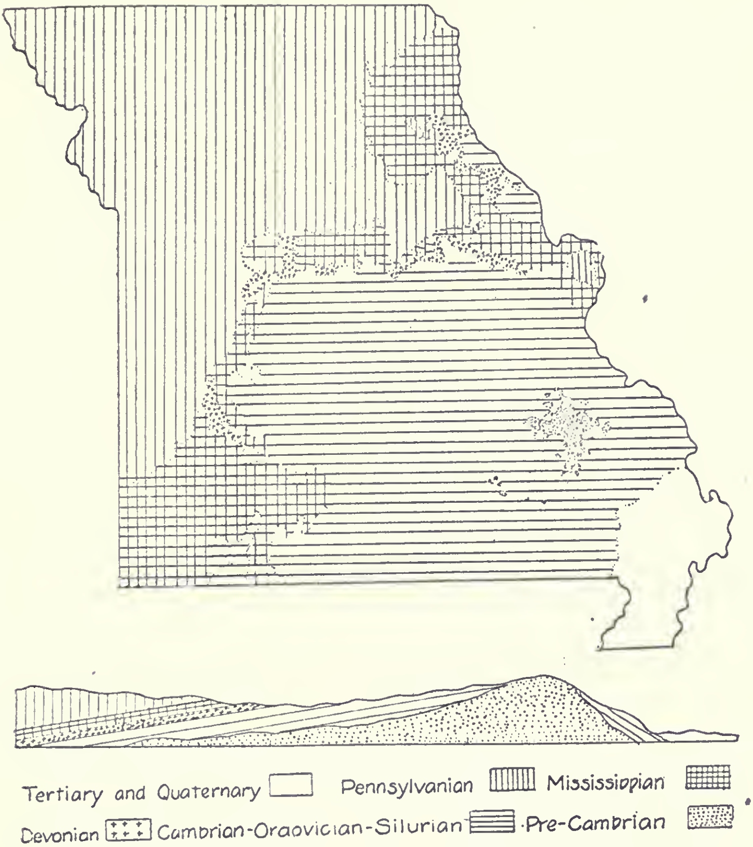

Fig. 2. Geological map and (northwest—southeast) section of Missouri.

posited. The Tertiary sediments are sands, gravels and clays, and are generally overlain by recent river deposits.

In the Tertiary period the rocks of the Ozark region were subjected to a gentle folding with the greatest uplift in the St. Francois Mountain region. This folding produced a dome-like structure with the rocks gently dipping in all directions from the center (Figure 2). In consequence of this uplift, erosion was accelerated with the result that the overlying rocks were stripped from the Ozark dome. The erosion was long and vigorous so that hundreds of feet of rock were removed and in the area of greatest uplift the old pre-Cambrian

floor of igneous rock is exposed. The process, indeed, is still in progress. The Pennsylvanian in all probability once extended across the Ozarks, but has receded scores of miles from the center of uplift. The uplifted edges of the various formations are being worn back from the center, not evenly, but irregularly, retreating more rapidly where erosion is most vigorous. Hence the geological map shows boundaries that are irregular but not so irregular as a more detailed map would show. Frequently an uneroded area is separated from the main body of rock and left as an outlier; for instance, Kings Mountain, in Howell County, remains to tell of the former extension of Mississippian rock, the main mass of which is now far to the westward.

**Mantle Rock.**—Overlying the bed rock is a layer of material generally loose and unconsolidated, so thick that in many places the bed rock is rarely visible. This is the mantle rock, or, as it is sometimes indefinitely called, the soil. This mantle rock may result from the decomposition of underlying rock (residual) or it may be transported from other places (transported). Any rock exposed to weathering will break up, the soluble parts disappearing and the relatively insoluble parts remaining as mantle rock. Heat and cold expand and contract the rock and freezing aids the general process of breaking up rock. Rain and ground water dissolve the more soluble constituents. Plant roots penetrate rock crevices and decaying plants yield humic acid which aids in rock disintegration. These are the principal agents of weathering.

A disintegrated granite yields mainly quartz and clay. Some igneous rocks of the St. Francois Mountains are so free from quartz that they have yielded considerable beds of pure clay. A sandstone, the cement of which is dissolved, yields sand. A shale usually yields clay with varying proportions of sand. A limestone, no matter how pure, contains some clay which remains after the rock is disintegrated. In Mis-

Fig. 3. Limestone with interbedded chert. Newton Co.

souri most of the limestones contain considerable chert or flint (Figure 3), which also remains in the mantle rock.

## II.—PHYSIOGRAPHIC PROCESSES.

All land surfaces are subject to **erosion** by which process the land is ultimately broken up and carried to the ocean, a process that in combination with variation in strength and attitude of rock determines most of our topography and drainage and greatly influences our soils. Normal erosion involves (1) **weathering**, by which process the land is distintegrated into such a state that it can be carried away by streams; (2) **corrasion**, by which streams cut their channels; (3) the carrying of the products of weathering, or **transportation** and finally (4) **deposition**, by which process the land waste is deposited en route or finally in the ocean.

**Weathering.**—This is inconspicuous when observed for a short time but in the long run it results in notable changes. Hills of crystalline rock in the St. Francois Mountains have been reduced to boulders, as in case of the "Elephant Rocks," huge to be sure, but only a fragment of the original mass (Figure 4). Solution by ground water in soluble limestones has given numerous caves through the Ozark region. Many of the principles of weathering have been discussed in preceding paragraphs.

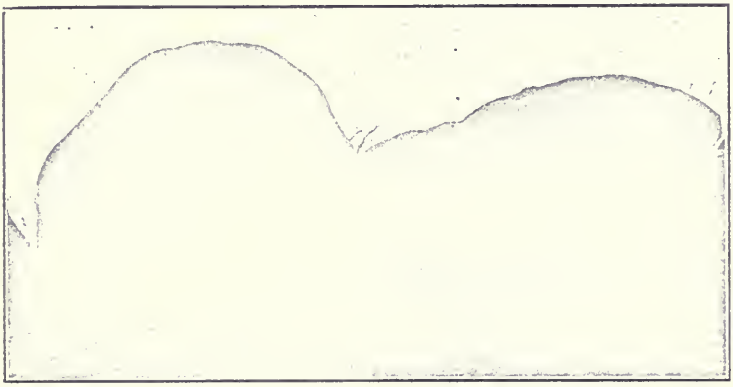

Fig. 4. "Elephant Rocks", Graniteville, Mo. They are residuals left from the weathering of a much larger mass ; "only a fragment of a much larger mass." Mo. Geological Survey, Vol. 8.

**Corrasion.**—When sand, silt, pebbles, and other products of

weathering are taken up by a stream, the various particles abrade each other and they in turn frequently abrade the stream channel. Thus water-carried particles become somewhat rounded or water worn. In most of Missouri, the stream gravels are largely of flint; their edges are rounded but the pebbles are mostly somewhat angular because the flint is so hard and because, for the most part, the gravels have not traveled far. This general process of wear by, and in the stream is termed **corrasion**. A swift stream largely corrades vertically while the corrasion of a sluggish stream is largely lateral. Valleys are deepened largely by corrasion while their sides are reduced by weathering.

**Transportation.**—By this is meant the carrying of the stream's load; it depends on many factors, including the stream velocity and volume, the amount of load already in the stream, the size, weight, and shape of the load. When any of these factors vary, the transporting power of the stream is affected. For example when a river overflows, its velocity over the overflowed portion is checked, and the stream is unable to carry its load, which is deposited. The Missouri is always muddy because of the fineness of its load. A rapid stream usually carries a coarser load than a sluggish stream. The load of the Missouri has increased since the tillage of the soils in the river's basin has made them more subject to erosion.

**Deposition** is the converse of transportation. The final destiny of a stream's load is deposition in the ocean although the load may be deposited and taken up many times before the final deposition. The temporary deposition of streams can best be treated in following paragraphs.

**Streams and Valleys.**—With few exceptions, valleys are largely the work of the streams which flow through them although weathering aids in widening the valley and furnishes much of the stream load. Streams whose corrasion is largely vertical cut comparatively narrow, steep-sided valleys. On the other hand, streams whose corrasion is largely lateral, are widening their valleys.

Streams with wide, flat-floored valleys which are covered at flood, build **flood plains**. These level plains, as the name implies, are built on each side of the river where the relatively sluggish water drops its sediment. Near the streams where the water is first checked the greater part of the stream's load is deposited and here, therefore, is a belt of higher land, the **natural levee**. The flood plain, then, typically includes the higher natural levee and the lower lands toward the limiting bluffs. Owing to the swifter water by which it was deposited, the natural levee is typically sandy and the lower lands are covered by silts and clays which were deposited by the sluggish water. The usual local name for flood plains is "river bottoms". A

tributary to a river that is building a flood plain can seldom enter the river directly, owing to the natural levee, but flows parallel until a confluence is found lower down the master stream.

Streams that enter a quiet body of water ordinarily build deltas. Except on a very small scale Missouri streams flow into larger streams and the conditions for delta formations are absent. However when a stream flows from a steep to a gentle slope, its velocity is checked and alluvial fans or cones are built. They are somewhat analagous to deltas but are built on land instead of in water. Typically they are found in the southern half of the state where streams flow down a steep slope into a flat floored valley where they spread out their detritus in a fan or cone shape. Farmers know them by the coarse, cherty soil and often locate homes on them because they are dry, and here shallow wells commonly reach living water.

The work of streams in meanders finds many illustrations in Missouri. The swifter current in a meander is found in the outer and down-stream side. Thus it follows that, in a meander, corrasion occurs on the outer and down-stream side, and deposition on the inner side (Figure 5). Meanders therefore tend to move down stream. There is also a tendency of a stream in a meander to cut across the neck of the meander, thereby shortening the stream course (Figures 47 and 48). The old channel is abandoned and becomes partly filled at flood. When these abandoned channels are crescentic in shape, they are called "oxbow" lakes; when they are of irregular shape they are called "sloughs". Both features are very common in flood plains.

Fig. 5. A meander of the Missouri near Glasgow. On the north (right) side the river is corrading its bank. On the south side it is depositing.

Many rivers of southern Missouri show **incised meanders** of which those of the Osage are among the best examples in the world (Figure 12). In flood plain meanders (Figure 11), the valley does not meander with the stream, but, in the case of incised meanders, both stream and valley meander together. The Meramec meanders are of this class. The projecting spurs are sharpened and finally eroded; near Pacific one of these meanders has cut through its spur, thus shortening the course of the stream. The isolated hill is thus left as the remnant of the once projecting spur.

**Glaciation.**—(45b: 48)*—Much interest is often shown north of the Missouri in the discovery of boulders and pebbles of quartz, granite, quartzite, greenstones and other rocks entirely different from the local rocks of the state. They are locally called "hardheads" or "lost rocks." In the early days they were widely used for mill stones. The geologist terms them **erratics** because they have been transported from afar. The agent that brought these erratics was a continental glacier that covered much of North America north of the Missouri and Ohio. There are no known outcrops of such rock further south than Minnesota. Some of them came from regions much farther northward.

During the glacial period, continental glaciers of the type now found in Greenland advanced southward from three centers in Canada. Glaciers, like rivers, corrade, transport and deposit material (drift) although not in the same way. A glacier corrades by pushing aside or along the mantle rock, much of which becomes imbedded in the ice. Furthermore, the rocks frozen in the base of the glacier act as tools by which the underlying rock surface is abraded. In a few places in the state the **scratches** made by these imbedded rocks are found when the overlying drift has been removed. The weaker rock such as limestone and shales that was carried on or in the ice was mostly ground up in transit and in consequence glacial drift the world over is largely of clay. Indeed, a common term for the drift is boulder clay. The most resistant rocks survived the journey and were finally left as erratics.

When the ice melted, its load was of course dropped upon the surface underneath and this deposited load constitutes the glacial drift. The drift in Missouri is largely of reddish, well weathered clay, generally with a large amount of flinty fragments. Erratics, except locally, are so rare as to become objects of some curiosity. It is probable that a large percentage of the drift, probably 90 per cent, is local and has originated from the shales and limestones within the state.

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*These numbers refer to items in the Bibliography, page 68.

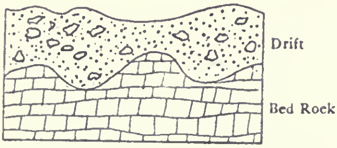

Fig. 6. Diagram to illustrate the concealment of the pre-glacial surface by drift.

The pre-glacial surface and its drainage in Missouri are practically unknown, but coal shafts and wells in various places have revealed what appear to be preglacial valleys in many cases not coinciding with the present valleys. The drift commonly masks the old topography except its larger features (Figure 6). It is safe to say that the old surface was much different from our present topography.

The glacial period did not consist of a single advance and recession of the ice, but rather of a series of recurring advances and retreats, each advance leaving its characteristic drift. The first advance in this region left the Kansan drift which covers North Missouri. This advance was followed by a long interglacial period and then four other advances followed, each separated by an interglacial period. The periods in order, beginning at the earliest, are the Kansan, Illinoian, Iowan, Early Wisconsin and Late Wisconsin. Their exposed drifts are shown in Figure 7.

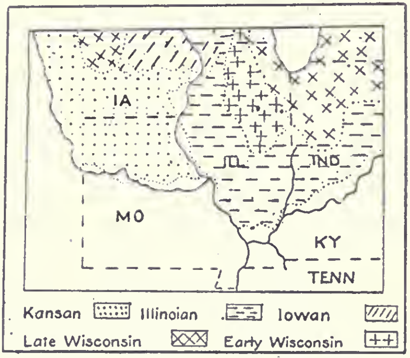

Fig. 7. Map showing the distribution in Missouri and adjacent states of different glacial drifts. after Calvin, Leverett and Todd).

Various features due to ice and the water from melting ice are found in the later drifts, especially the Wisconsin. Moraines or accumulation of drift beneath the ice or at the margin; out-wash plains, made by the water from the melting ice; drumlins, which are ovoid hills of drift, and other surface features are found in the later drifts. None of these forms have been recognized in the Kansan drift. Either they were never formed, or, what is more probable, they were largely removed by the long continued erosion to which the Kansan drift has been subjected. It is probable that intensive study of the Kansan drift will reveal traces of these features, but to ordinary observation the Kansan drift is a mantle of clay and chert fragments with a fairly level surface except where erosion has been active. In Missouri the drift thickens greatly to the north,

not infrequently in the northern counties reaching a thickness of 150 feet. Its southern margin is very indistinct and here it is with difficulty that the drift is distinguished from the mantle rock due to ordinary weathering.

The Loess.—This is a fine loamy surface deposit extending principally in belts along the Missouri and Mississippi Rivers, and hence often called "bluff formation". It is usually thickest at the bluffs and thins out at varying distances from them. Its limits are indefinite because the loess becomes thin and also in many places resembles the mantle rock derived from local rock disintegration.

In physical composition loess is intermediate between finest sand and silt. It is usually yellowish except when mixed with humus, when it is dark. Loess is often called clay, but unlike clay, it does not become very plastic when moist. A notable peculiarity of loess is that exposed surfaces remain practically uneroded and stand vertical for years (Figure 8). This is well shown in Kansas City which is built upon this formation.

Fig. 8. A road cut in loess, Saline Co. The cut is about 30 feet deep.

There is still discussion as to the origin of loess, but so far as its origin in Missouri is concerned, the loess is probably fine dust derived from river deposits and deposited by wind. The alternative theory is that it is deposited by water, but in Missouri it is hard to explain by this hypothesis its distribution in a narrow zone along the Missouri. Loess covers large areas in Iowa, Illinois, the central Rhine valley, China, and is rather widely distributed over the world. It forms in general an exceedingly fertile soil.

Land Forms and Their Underlying Rocks.—Erosion is the primary factor by which the land is worn away, but the strength, arrangement and attitude of rock are modifying factors that in part determine the altitudes and shapes of the land forms. If rock be the same throughout, the surface forms will depend entirely upon the activity of erosion. Where erosion is active, the surface will be lower and rougher than where erosion is less efficient. Thus in the thick glacial drift which is practically homogeneous, the hills, valleys, divides, and other topographic features will be due solely to the activity of erosion. A common example of this is that, in the prairie region, the surface becomes more cut up (dissected) near

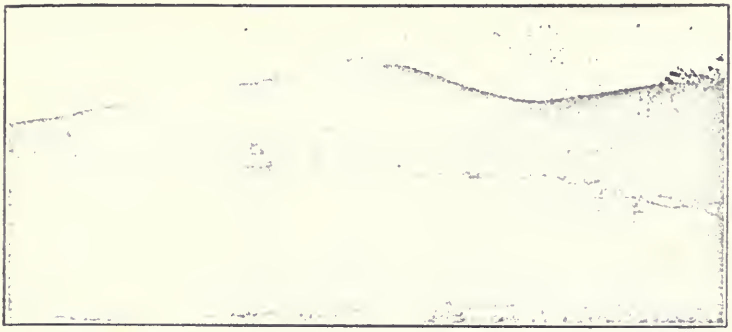

Fig. 9. Pilot Knob, a hill of strong crystalline rock from which the once overlying weaker limestones have been eroded. The valley in the foreground is underlain by limestone. (courtesy of the Mo. Pac. R. R.)

the larger streams, for there the tributaries are more numerous and slopes are steeper.

Where the rocks differ in strength, the stronger formation makes a higher and often a less dissected surface than the weaker. Thus the strong, hard crystalline rocks of the St. Francois Mountains stand above the areas of adjacent weaker rock and are less rugged in outline (Figure 9). If rocks of unequal strength are tilted, the same principle applies, but the shapes of the land forms are different. The underlying weaker rock weathers faster than the overlying stronger rock and the result is a steep slope often forming an **escarpment**. The strata overlying the stronger rock is stripped away, leaving a slope largely determined by the dip of the stronger rock. Typically, then, the net results of erosion in tilted rock of varying strength is a series of escarpments with gentle slopes extending back from them and all these forms somewhat parallel. Figure 10 shows an application of these principles in Missouri.

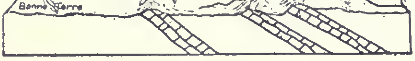

Fig. 10. Diagram to show three escarpments in southeastern Missouri. They are formed by erosion upon a series of tilted rocks. The strong strata are least eroded and make the escarpments. (after Marbut, 45a).

**Stages in Land Forms.**—The land forms of a given region are not fully described when we know only the strength, structure and attitude of the underlying rocks. If erosion is but beginning its work in a region, the topography will be different from that where

erosion has been long and vigorously at work. To illustrate we shall use an example already mentioned in a different connection. The level prairies in North Central Missouri are in many places poorly drained because the streams are not organized for their work. The streams are few, their tributaries are not well developed, they flow in shallow, narrow, steep-sided valleys of low slopes. The divides are wide, flat, and not distinct, and in consequence of the gentle slopes, the run off of rainfall is poor. Erosion has but begun its work of reducing the land to sea level.

If we follow the streams to an important master stream, we find the topography and the stream habits are changing. The increased slope and volume of the streams give them greater efficiency As a result, the tributaries become numerous, the divides narrower and more distinct, the valleys are deeper and wider. In other words, we pass from the prairies to the "rough country," from erosion at its early inefficient stage to its more efficient stage. For the sake of conciseness we say that the prairie is in the **youthful stage** and the rough country is in an early **mature stage.**

In maturity streams are at their maximum vigor, the region is thoroughly drained and the topography relatively rugged. Later the valleys widen and the main streams develop such gentle slopes that the streams begin to erode laterally.

After long continued erosion, the stage of **age** appears. In this stage the divides are worn to gentle rounding outlines, the valleys are relatively shallow, the streams have low gradients and the topography becomes "rolling" instead of rugged. The landscape regains something of the appearance of youth, but the developed stream organization secures good drainage.

It should be remembered that the time during which a region passes through the stages of the cycle or erosion varies with many factors, chief of which are the vigor of erosion and the strength of the rocks. The interesting Osage valley furnishes a fine example. (Figures 11 and 12). In the upper valley in the weaker rock the slopes are gentle, the valley is wide, the divides broad and rolling, and the stream is relatively sluggish. The lower valley shows contrasts in all these features. In both cases the stream meanders but, in the upper valley, the meanders are of the flood plain type while, in the lower valley, they are incised. The upper valley in the weak rocks has reached the stage of late maturity or age while during the same period, the lower valley in the stronger rocks has only reached middle maturity. Thus the upper valley, while younger in age, is older in stage.

To understand and appreciate the physiography of Missouri, one must have in mind these three basal factors, **process, structure,** and

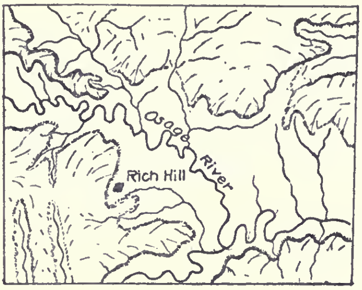

Figure 11

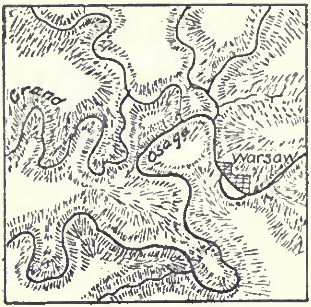

Figure 12.

Fig. 11 shows the wide upper Osage valley in *weak* rock. In Figure 12 is shown the narrow lower Osage valley in *strong* rock.

stage, which will be used in the following chapter to describe the various provinces of the state.

## III.—PHYSIOGRAPHIC PROVINCES OF MISSOURI.

The foregoing principles all have notable application in Missouri. It is first to be noted that Missouri is not sharply distinct physio-

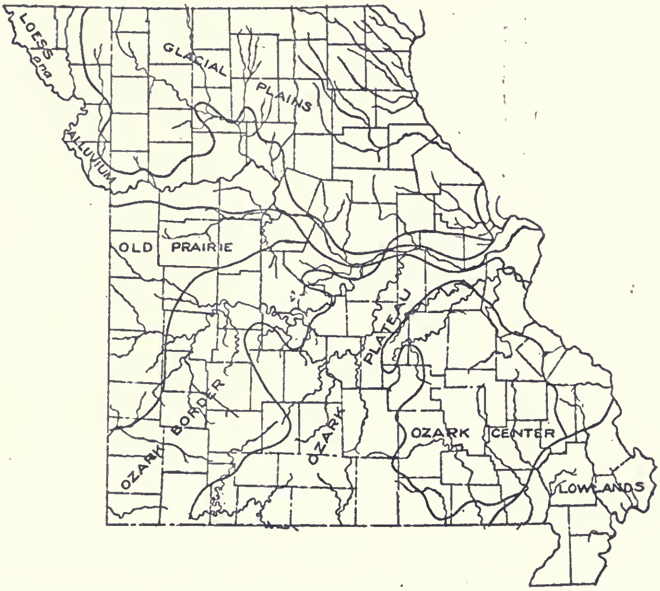

Fig. 13. Physiographic Provinces of Missouri. (after Marbut).

graphically from the bordering states and that the various topographic divisions or as frequently called, physiographic provinces, are not confined to this state but are shared with neighboring states.

Four areas, markedly distinct in topography and usually distinct in geology and soils, are to be found in Missouri: The Ozarks, the Prairies, the Mississippi Lowland, and the Mississippi-Missouri valleys. (Figure 13).

## THE OZARKS.

We have noted in preceding paragraphs that the rocks of Missouri dip gently away in all directions from the St. Francois Mountains and that the younger overlying rocks once covering the crystalline rocks of the St. Francois Mountains, have been eroded, leaving the old rocks exposed along parts of this center of uplift where the up-folding was most pronounced. The rugged country about this center of uplift is everywhere known as the Ozarks, but the division between the Ozark's and the Prairies is both geological and physiographic. The outer rim of the Ozarks in Missouri is defined by the Mississippian (Figure 2), although in Arkansas the Ozarks also include the dissected country underlain by the Pennsylvanian. The Ozarks in general are more dissected than the prairies and in general are higher although it must be remembered that there are large areas of level country in the Ozark region and, moreover, considerable areas of dissected country in the Prairies.

The Ozarks as a whole may be conveniently divided into four regions: the Ozark Center, the Ozark Plateau, the Ozark Border, and the Boston Mountains, the latter being in northern Arkansas. The distribution of these provinces is shown in Figure 13. The boundaries between the provinces as shown in the map are generalized. Indeed the exact boundary between the divisions can seldom be located by one on the ground. If exactly drawn, the boundaries would be much more irregular than shown in the generalized map.

**The Ozark Center** is not the geographic, but rather the geological center, of the region. Here are the oldest rocks surrounded by semi-concentric belts of younger rocks. The distinction between these and surrounding areas is also topographic. Here is the most dissected area in the Ozarks. There are practically no level areas except very narrow flood plains along some streams. It is a maturely dissected region.

The Center is composed of a core of very old crystalline rocks, mainly granites and porphyries and a surrounding belt of sedimentary rocks, mostly limestones. The hills on the crystalline rocks are

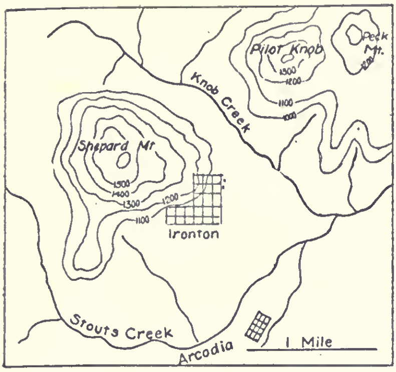

Fig. 14. Map of a portion of the St. Francois Mountains.

rounded and somewhat dome-shaped (Figure 14). They are not the result of recent erosion but were eroded in pre-Cambrian time, then covered by sediments which hardened into rock, and have again been exposed during the present cycle. The old pre-Cambrian surface is most thoroughly exposed in the St. Francois Mountains from which the overlying limestone has in some cases been entirely stripped and in other instances, for example in the Arcadia Valley, a small area of limestone still lingers in the valleys (Figure 15). As far west as Shannon County, these old hills have been uncovered either singly or in groups and, so to speak, stand as islands in an ocean of limestone.

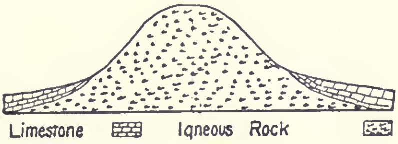

Fig. 15. Section from Arcadia, northwestward across Shepherd Mountain. See Figure 14. (Vertical scale greatly exaggerated).

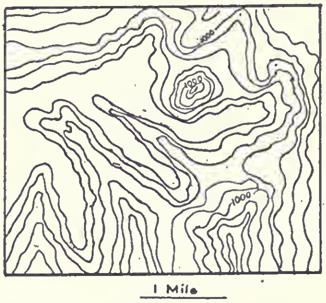

Fig. 16. An area in the limestone region of the Ozark Center. Contour interval 100 feet. DeSoto Quadrangle, U. S. Geological Survey.

The hills in the sedimentary rocks of this province are due to the erosion of the present cycle. The surface of the original plain has been so thoroughly cut up that the topography is mainly one of steep slopes, of long narrow irregular ridges between steep sided valleys. Figure 16 shows an area rather typical of the limestone Ozark Center.

**The Ozark Plateau** occupies the west central part of the Ozark

region in Missouri. It is a dissected plateau and a considerable portion of the old plain surface still remains on the relatively flat divides. The underlying rock as elsewhere in the Ozarks in Missouri is mainly limestone. The southern part of the plateau is rougher than the northern part.

**The Ozark Border** surrounds the outer provinces in a nearly complete circle. It is an irregular zone developed in gently tilted strata of limestone. This zone is transitional between the dissected Ozarks and the smooth prairies. Its topographic features are easily explained in light of the preceding discussion of tilted rocks. In general, the rock underlying the Mississippi limestones which form this province is relatively weak. Here, then, we have conditions which favor the development of a steep slope facing the Ozark Plateau and a gentle slope extending toward the Prairie Plains. The diagram, Figure 17, illustrates these features. The upturned edges of the Mississippian limestones are eroded less rapidly than the underlying limestone. This escarpment, termed by Marbut the Burlington escarpment from the overlying Burlington limestone, is a persistent feature in Southwestern Missouri. It extends for miles, not as a clear cut slope but as a dissected range of hills. West of this escarpment is a plain, termed by Marbut the Springfield Plain,

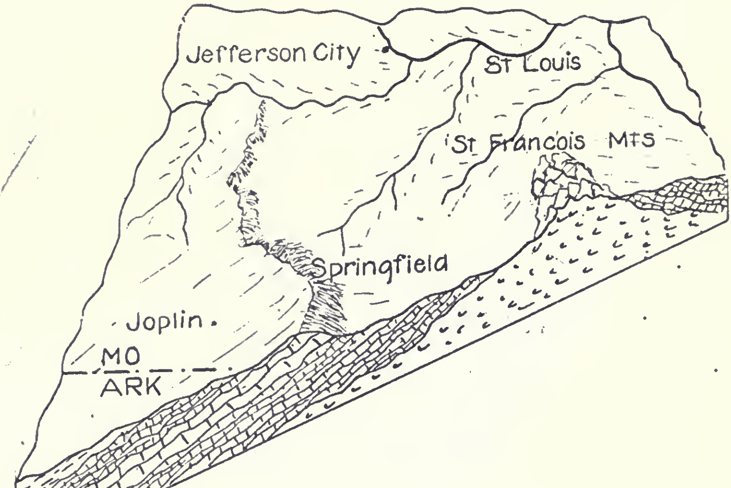

Fig. 17 . Diagram showing the relations of the Springfield Plain, Burlington Escarpment and St. Francois Mountains to the underlying rocks.

which is a part of the Ozark Border. (45a). In general the Border is relatively smooth as compared with the rest of the Ozark region and slopes gently away from the Center. Indeed the border in Southwestern Missouri is frequently called the "Southwestern Prairies".

**Evolution of Ozark Topography.**—While a wide view over almost any portion of the Ozarks in Missouri shows a rough surface, yet it is seen that the higher hills reach something of the same altitude. Moreover a considerable number of relatively smooth high areas are found. A notable example is the broad flat ridge along the Frisco Railroad from Pacific to Springfield. The railroad runs for miles on a surface where there is no more cut and fill than in the prairies. These and other facts point to a time when the Ozarks in Missouri, at least, were worn to a fairly level plain. Long continued erosion after the doming of the Ozark region reduced the area to a fairly level, low plain. The entire region was then elevated with the result that the streams acquired new energy and the present topography is due to erosion on this old plain. The Ozark region in Missouri is therefore an old plain which is maturely dissected.

Expressing these facts concisely, the Ozark area was nearly peneplained, a re-elevation interrupted the first cycle and started another cycle in which we now find the topography. As before stated, several remnants of the old plain still stand unreduced. They are usually called prairies and are especially numerous near the border. The narrow, long, unreduced area between Pacific and Springfield

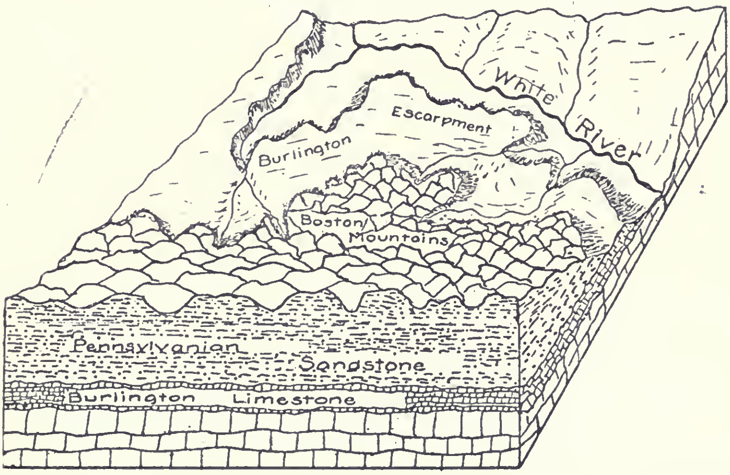

Fig. 18. Diagram showing the Boston Mountains and the Burlington Escarpment, and their relations to the underlying rocks.

occurs because it is the divide between the Missouri and Mississippi drainage. The stream head waters have not yet reached the flat divide and dissected it. Generally speaking, the dissection is greatest at the geological center and decreases outward, although there are many exceptions to this statement.

**The Boston Mountains** (41; 23) are in Arkansas south of the Ozark border. In structure they are a counterpart of the Burlington Escarpment. They are underlain by Pennsylvanian shales and sandstones, under which are the limestones of the Mississippian; all of the rocks dip southward. Hence the Boston Mountains are a dissected plateau much rougher and less fertile than the adjacent Ozark Border and Plateau to which it descends by a well defined, irregular escarpment in places several hundred feet in height (Figure 18).

## THE PRAIRIE PLAINS.

The Prairie Plains are distinguished from the Ozarks by their topography and geology. As the surface of the Ozarks is largely the result of the underlying rock, so the main features of the prairies are largely due to their underlying formations. While the prairie plains are generally level or rolling, yet portions are quite as much dissected as any area in the Ozarks. The rocks underlying the prairies are coal measures or Pennsylvanian, and are largely shales and limestones. Like the rocks of the Ozark region, they dip away from the Ozark Center but at a very low angle. From such a structure is derived the succession of plains and escarpments as is found for example in the Burlington Escarpment and the Springfield Plain, but these features are not generally so pronounced as in the Ozark region.

South of the Missouri River the Prairie Plains are rolling. Wide,

Fig. 19. "Wide valleys and rounded divides" in the Old Prairie, Barton Co.

gentle sloped valleys, streams with gentle grades and broad flood plains, and broad, rounded divides are characteristic (Figue 19). The streams are well organized and numerous branching tributaries aid in the drainage. The Prairie Plains north of the Missouri are level except for the relatively narrow and steep sided valleys (Figure 20). The divides are flat rather than rounded and the streams have not extended their tributaries to drain the entire surface of the flat divides, although many of the larger streams are graded. In short, the southwestern prairie plains are mature in stage, while the northern plains are youthful or early mature. The prevalent shales of this division south of the Missouri have worn more rapidly than the limestones of the Ozarks and hence are in a later stage, although the same age. The same stage was undoubtedly reached in the northern plains, but these were covered by glacial drift which has partly masked the smaller topographic details and superimposed on the old surface a topography that is relatively young. Along the boundary between the upper and the lower coal measures on an irregular line from Cass County to Mercer County, there is a well marked escarpment.

Fig. 20. Rolling Glacial Prairie. Sullivan Co.

It should be remembered that these descriptions are general and considerable areas in each are exceptional. Along all the larger streams there is a belt of dissected country even in the southwestern plains. These prairies extend northward and westward and form a part of the plains of the Mississippi Basin.

It will be evident that there are two great types of prairies, the old and the new, or the prairies developed by long erosion on the relatively weak coal measures of the southwest and the prairies on the recent covering of glacial till over the northern half of the state. In contrast with the Glacial or New Prairies the prairies of south-

western Missouri can be termed the Old Prairies. The New Prairies are largely constructional in origin; the Old Prairies, largely destructional. The Old Prairies have the smoothness of long continued erosion; the New Prairies that of but brief erosion.

## THE MISSISSIPPI LOWLAND.

This lowland is usually known in the state as the Southeastern Lowland. It begins near Cape Girardeau and extends southward through Arkansas to Mississippi and Louisiana and forms what is called the Mississippi Lowlands. The discussion will be confined to the part in this state and is entirely a condensation of Professor Marbut's excellent monograph of the region (46).

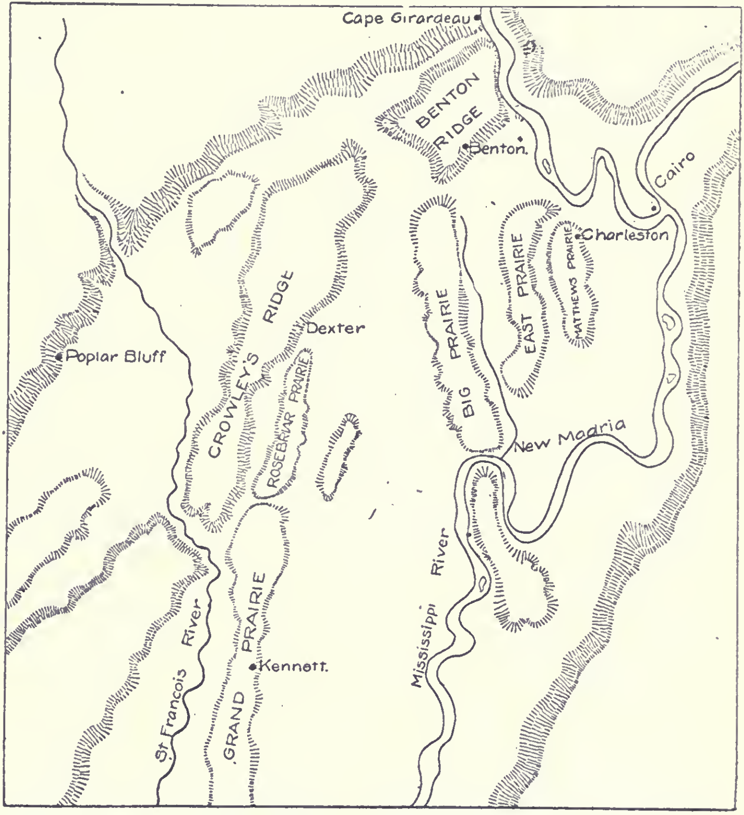

Fig. 21. Map of the Mississippi Lowlands in Missouri.

The southeastern lowlands, as its plural name implies, is not a single physiographic division, but rather three lowlands separated by two well defined ridges, one of which, Crowley's Ridge, is sharply defined. The main features are brought out in the map, Figure 21.

From Cape Girardeau southwestward past Poplar Bluff is a well defined bluff, in places 200 feet high. Southeast of this bluff is a lowland which is limited by Crowley's Ridge. This ridge, although not high, is a prominent feature because of its relative height above the level lowlands. Near Delta it is broken by a wide gap and is continued northward by a ridge known locally as Commerce Hills or Benton Ridge. East of Crowley's Ridge is a wide level, lowland which is interrupted at Sikeston by a low, inconspicuous ridge extending southward past New Madrid. Beyond this ridge is a lowland extending across the Mississippi into Kentucky and Tennessee.

The broad eastern lowland, the prominent Crowley's Ridge and the narrow western lowland have long excited inquiry as to their origin. As early as 1818 the traveler Darby, looking from Poplar Bluff, observed that the western lowland "must have been an old course of the Mississippi" (9a).

The development of this region illustrates on a large scale the process of stream capture by which one stream may send out a tributary and annex another stream. Formerly the Mississippi River turned southwestward at Cape Girardeau and flowed along the western lowland past Poplar Bluff. The Ohio flowed somewhat west of its present course, the two river courses being approximately parallel. Under such conditions, one stream is very likely to lower its channel faster than the other. The tributaries of the stronger stream have an advantage and they will ordinarily extend back and divert the weaker stream into the stronger. In this instance the Ohio was the stronger. In Figure 24 the early approximate position of the two rivers is shown. Both had reached grade and had opened wide valleys, that of the Ohio being much the wider. Crowley's

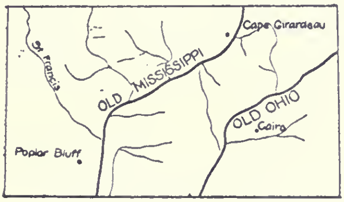

Fig. 22. First relative positions of the Old Ohio and the Old Mississippi. (after Marbut. 46).

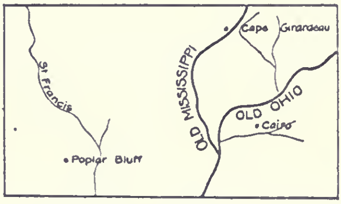

Fig. 23. The courses of the Ohio and the Mississippi after the first capture. (after Marbut. 46).

Fig. 24. The Gorge of the Mississippi. Benton Co. (after Marbut).

Ridge then extended a considerable distance farther east than at present. Finally a tributary from the Ohio extended northwestward through Crowley's Ridge, captured the Mississippi near Delta and diverted the river into the Ohio (Figure 23). The Mississippi followed this course and opened a valley nearly ten miles wide, this valley now separating Crowley's Ridge and Benton Ridge. Again the masterful Ohio reached northward by a tributary and captured the Mississippi near Commerce, and this new valley is the one now followed by the Mississippi (Figure 24). This valley has a width of only about a tenth that of the valley due to the first capture, and its narrowness shows how much more recently it was made.

Summarizing, Crowley's Ridge, formerly wider than at present, lay between the Ohio and the Mississippi. Both rivers had passed from youthful to mature habits and had opened wide valleys. The Ohio, being somewhat lower and carrying a load less heavy than that of the Mississippi, possessed an advantage over the latter. Twice the Ohio tributaries reached backward and captured the Mississippi; once at the gap near Delta and later at the present gorge at Commerce.

## THE RIVER LOWLANDS.

Flood plains fringe not only the Mississippi and the Missouri, but many of their more important tributaries. Their total area constitutes a not inconsiderable portion of the state. The general features of these alluvial lowlands are simple and have been discussed before. Their streams are practically all graded. They meander

freely in their flood plains, at places touching the enclosing bluffs. The natural levee with its sandy soil is found along the stream and lower land or swamps are found back towards the bluffs. Fragments of natural levee, cut off lakes and sloughs mark old and deserted channels of the rivers. The Missouri flood plain between Kansas City and St. Louis has an average width of less than three miles for the eastern half. The western half, which is in the weaker coal measures, is nearly three times as wide on the average. It is also wide above Kansas City. The Mississippi flood plain has an average width along the state of about five miles, but near Cape Girardeau it narrows to about a mile. Below Commerce the flood plain widens and becomes merged in the Southeast Lowland. Along the state line, more of the flood plain is in Illinois than in Missouri. The Grand and Chariton have flood plains five or more miles wide and many other streams, especially in the prairies, have wide flood plains.

## IV.—SOILS OF MISSOURI. (73, 74)

A description of the known facts about the soils of Missouri would fill several volumes and only a beginning of soil investigation has been made. Here perhaps more than in any other subject the average person, whether a farmer or not, can do first-hand research work. The soil composition, structure, texture, and moisture can be easily observed while all about are the crop laboratories where the responses of crops to various soil types and methods of cultivation are easily observable and are profitable for study from an economic standpoint. For school work, the study of soils is an unfailing source of interesting materials.

Soils from a physical point of view may be considered under three heads, their texture, the topography of the region, and their origin. Texture ranges from heavy clays and silts through the medium loams to the light sands. Loams are mixtures of clay or silt with sand. If the sand and other constituents are about equal, it is a loam; if the clay predominates, we have a clay loam, or if the sand predominates, it is a sandy loam. A full description of the different types may be found in almost any book on soils.

The topography is of vital importance in soil drainage, itself a most important factor. If there is the good stream development of early maturity or age, there is good drainage, as in portions of the glacial prairie near the principal streams. Where the region is in youth, the surface flat, the stream organization poorly developed as in portions of the glacial prairies and lowlands, the drainage is poor. Again in regions of mid maturity, drainage is too good for the soils. In the loess belt the balance between rainfall and run off is such that a plentiful humus has been produced and these soils are

extremely fertile. The relation between stage and soils is easily observed and is an interesting local study.

As to origin, soils may be derived from the underlying rock (residual) or be carried into the region (transported). Residual soils, of course, vary with the kind of rock from which they are derived. Limestone in general yields clays, silts, and heavy loams which are the prevailing soils of Missouri. Shales yield soils varying with the composition of the parent rock, and ranging from heavy to sandy loams. Sandstones yield sands and sandy loams. Very interesting variations in soils derived from different rocks arranged in narrow belts are found in the Ozarks of which a fine example is described in the Soil Report of Cape Girardeau County (74).

The most important transported soils are those carried by water (alluvial), by ice (glacial) and by wind (aeolian). The alluvial soils of the flood plains are prominent in Missouri since nearly every important stream is flanked by these "bottom soils." Typically the higher natural levee is of sands and sandy loams, while the lower back lands have clays, silts, and heavy loams. Corn grows well upon the higher loams and wheat upon the heavier soils, so that one may often stand on the bluff overlooking a broad flood plain and see the different soil types mapped by appropriate crops on the flood plain beneath. However, owing to the meandering habits of most of our larger streams, the alluvial soils are of an arrangement far from simple. Figure 25, which shows a small area of alluvial soils, will indicate their "patchy" arrangement.

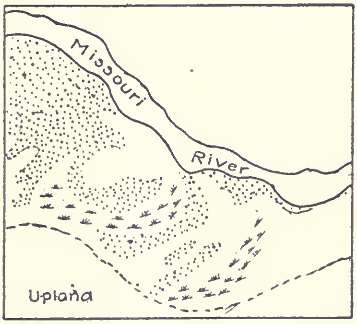

Fig. 25. Flood plain soils along the Missouri. The dotted areas represent sands and sandy loams; the other areas are silts and clays. Saline Co. (U. S. Soil Survey.)

The glacial soils cover approximately one half of the state. They are derived from weathered drift which is largely composed of clay. The glaciers in reaching Missouri passed over large areas of limestone and in consequence the till is largely composed of limestone products and of their disintegration. The soils are largely clays and loams. Their texture is rather uniform and drainage and topography are especially important factors. The glacial soils in this part of the Mississippi Basin rank high in fertility.

Although of not great area in the state, the loess is a very productive soil, these soils being perhaps the most productive in the

world. Under another paragraph it was noted that there is still some discussion as to the origin of loess, but in Missouri it is generally considered as wind blown, or eolian. It is usually a silty loam with its soil dark from included humus and its subsoil yellow in color. The glacial soils, as has been before noted, vary considerably with the topography, since the till from which they are derived is remarkably uniform. The rolling prairie has good drainage and is productive. The level prairie has comparatively poor drainage, but when drained, is fertile. The Black Prairies are portions of the Glacial Prairies which have a somewhat slow drainage and a high percent of humus, or partly decayed vegetable matter. They are a part of the famous black soil area of the Middle West.'

The soils of the Old Prairie are clays, silts, and heavy loams for the most part. These heavy soils need adequate drainage which is provided by the mature drainage and excellent run off of the region. In general, these soils are productive far above the general average of the United States.

Alluvial soils, other things being equal, are among the most

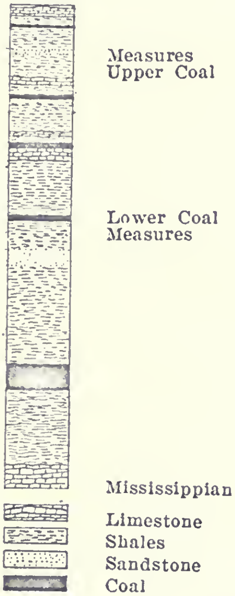

Fig. 26. Section of upper and lower coal measures in Macon Co. The total thickness is about 180 feet. (after Gordon, Mo. Geological Survey).

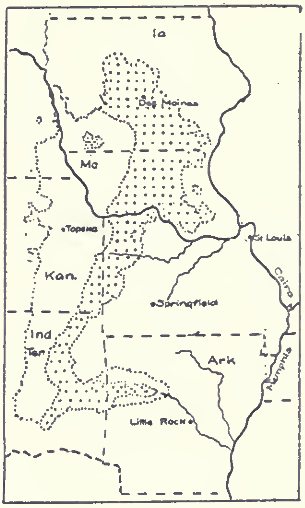

Fig. 27. The Western Coal Field. The dotted area indicates proved workable coal; the enclosed area, possible workable coal. (U. S. Geological Survey 41).

productive. But in most cases, they require somewhat expensive artificial drainage. The state law provides for drainage districts and they have been organized to a slight extent along the Missouri and the Mississippi and to a considerable extent in the lowlands. The soils of the alluvial belt show all variations from heavy clays to sands.

The Ozark soils (73) as would be expected show a great variety. As we have seen, there are many outcrops of different rocks due to the gentle up-folding of the region. Again there is every gradation in dissection from the prairie-like areas of much of the western border to the minutely dissected areas of the center. These various stages of dissection with their varying degrees of drainage and erosion would yield a variety of soils quite independent of the variable underlying rocks. Most of the Ozark rocks are limestone often containing considerable chert. The resulting soils are largely clays, silts, and heavy loams, which are much modified by various degrees of erosion to which they have been subjected. Compared with the other types of soils in Missouri, the Ozark soils as a whole are relatively infertile, although in more densely settled states, a high percentage would be classified as productive. The methods of extensive agriculture that prevail on the prairies must be modified for the Ozark soils.

## V.—MINERAL DEPOSITS OF MISSOURI.

**Coal.**—(33, 41). We have briefly referred to coal bearing rocks of the Pennsylvanian period whose distribution is shown in Figure 2. The origin of these coal beds is explained in all text-books and need be treated here only in outline. First, there were extensive swampy areas in which vegetable matter accumulated and was partially preserved from decay. At times these swamps were submerged beneath the sea and the sand and mud deposited over the accumulated peat beds, and ultimately hardened to sandstones and shales. The accumulations and oscillations recurred many times, resulting in alternating beds of rocks and coal, the coal always forming but a small fraction of the total thickness of the coal measures or rocks in which coal is commonly found. The arrangement is well shown in the section (Figure 26) in one of the best fields in the state where but a small per cent of the total thickness of coal measures is coal, and not all the coal is workable because of the thinness of the seams. The coal of Missouri is bituminous and the coal field is part of the western field, one of the largest fields in North America, covering portions of several states (Figure 27). Much of the coal is undeveloped.

**Iron.**—The early exploitation of lead in Missouri led to the discovery and ultilization of the iron ores in the lead district About

1816 a furnace near Ironton smelted ores taken from Shepherd Mountain. In the thirties the rich ores of Iron Mountain and Pilot Knob were utilized. The production was increased by the building of the Iron Mountain Railroad, which was extended to this region in 1858 when an outlet was provided for the ore. The production increased, reaching its maximum in 1887, after which it declined, owing to the exhaustion of the rich bodies of ore. In Crawford County ore was mined and smelted in the twenties. The map (Figure 28) shows considerable ore in the state, but at present it is largely unworked because of the rich accessible ores in the Minnesota, Wisconsin and Alabama fields.

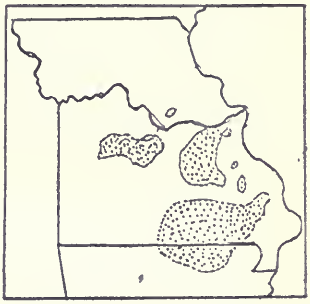

Fig. 28. Principal iron ore regions in Missouri, 1909. (U. S. Geological Survey).

**Glass Sand.**—The Cambro-Silurian have several beds of thick white sandstone that is mostly unconsolidated. In the early thirties these beds were explored and their usefulness for the manufacture of glass was appreciated. Glass sand from the beds below St. Louis was early an important product, some of it being shipped as far east as Pittsburg. Cheap coal and sand, together with a good market, have been factors in concentrating an important center of glass manufacture at Crystal City, St. Louis, and that vicinity.

**Lead and Zinc** (37, 38, 39, 40, 41, 42) occur in many counties of the state, but the prominent areas that are now productive are in three districts, the southeastern, central and southwestern (Figure 29). Zinc and lead may be described together, since they are often associated minerals; they occur together in the central and in the southwestern districts.

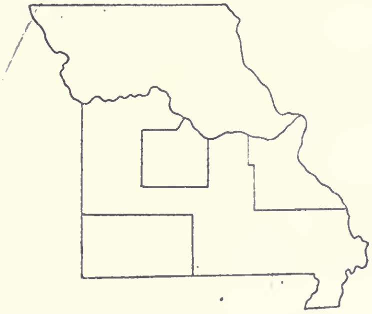

Fig. 29. Map showing the main lead and zinc districts in Missouri. (after Winslow).

The principal ore of lead in Missouri is galena, a mineral composed of lead and sulphur. It is a heavy, dark colored mineral, locally called "blue mineral." The principal ore of zinc is sphalerite, composed of zinc and sulphur. Local names are "Jack," "black jack,"

"rosin jack" and "blende." Zinc carbonate and zinc silicate are also found. The ores are always associated with rock and other minerals, called "gangue," from which they must be separated. The ores may be scattered in small particles through the rock (disseminated) or in irregular bodies (Figures 30 and 31). Again they may be in small, irregular masses in the mantle rock. This latter form was the one usually mined in the early days, since it was most accessible. Geologists agree that lead and zinc ores were deposited by water percolating through the rocks, but why the ground water concentrated the deposits in certain districts is still undecided.

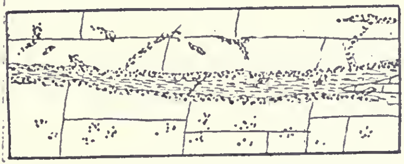

Fig. 30. Lead ore in limestone. St. Francois Co. (after Buckley).

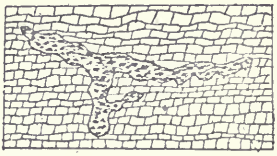

Fig. 31. An irregular zinc ore body in limestone. Lawrence Co. (after Winslow.)

## VI.—CLIMATE OF MISSOURI.

Like the physiographic provinces of the state, the climate of Missouri is not peculiar to this state, but rather is shared with the surrounding states of the Central Mississippi Basin. For our purposes the climate of Missouri can be described under four heads: sunshine, temperature, precipitation and winds. Climate is distinguished from weather in that it is the average condition of the weather. Weather is the condition for a shorter period. Thus we speak of the climate of Missouri, but the spring weather or the weather for a day or a week.

Sunshine as generally used means the time during which the sun is shining. It depends mainly on two factors: the length of day and the degree of cloudiness. In this respect Missouri's sunshine reaches about 60 per cent of possible sunshine, which is 10 per cent above the average for the United States.

Temperature is the resultant of several factors. The primary factor is the heat from the sun (insolation) which varies with the inclination of the sun's rays and with the length of day. Winds transport warm or cool air from one region to another. Temperature on the average the world over decreases with altitude at an average rate of one degree for every 300 feet, a rate, however, subject to great local variations. Radiation of heat already absorbed varies with several factors, including the state of the sky, clear or cloudy, wind move-

ment and the nature of the soil. Slopes are locally very important.

Temperature records should show many facts aside from the mean annual temperature that is usually given. For example, the mean annual temperature of Missouri is 54 degrees. This does not indicate its seasonal, monthly or daily distribution, and crops must be handled with respect to the seasonal temperature and to maximum and minimum temperatures. In other words, the average hot and cold periods should also be given.

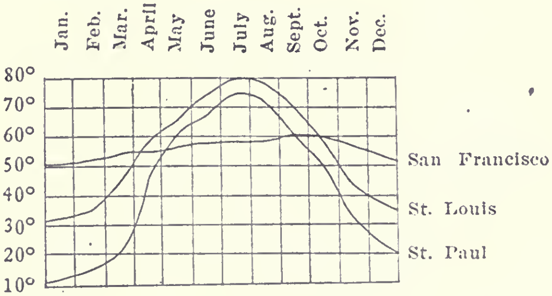

Fig. 32. Annual temperature graphs of St. Louis and St. Paul (continental) and San Francisco (marine).

The yearly temperature type of Missouri, like that of all the interior states, is continental as compared to portions of the Pacific States, which is marine. The graphs in Figure 32 of St. Louis and St. Paul and of San Francisco bring out the contrasts of the two types. The continental climate has great extremes of summer and winter and the same contrasts appear in the daily temperatures (Figure 33).

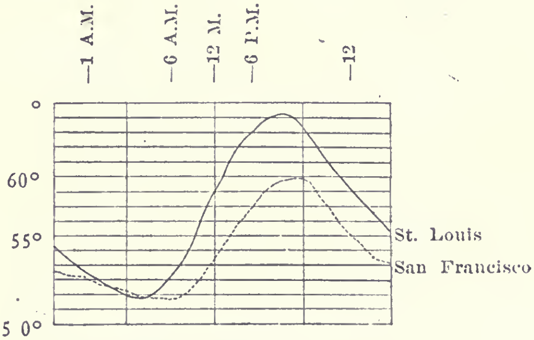

Fig. 33. Graphs of daily temperatures, St. Louis and San Francisco.

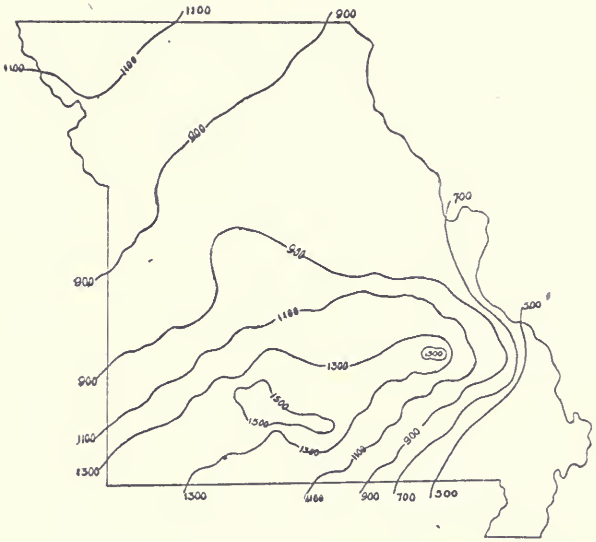

Fig. 34. Contour map of Missouri. Contour interval, 200 feet. (after Marbut, 45a).

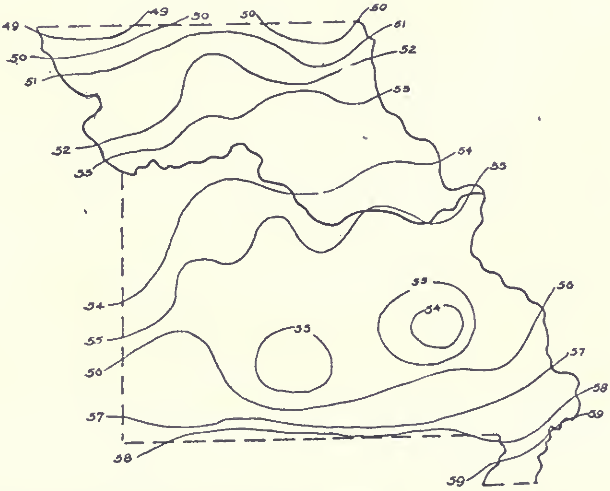

Fig. 35. Annual temperature map of Missouri from averages of 21 years. (after George Reeder, U. S. Weather Bureau).

There are no great extremes of elevations in Missouri as a whole. The higher Ozarks show a somewhat cooler temperature, but the tendency is checked by their more southerly position. The isotherms (Figure 35) show a difference in annual temperatures of about ten degrees between the northern and the southern parts of the state. The higher altitude and more northerly latitude account for the more rapid change to the northwest. Two cool areas in the Ozarks are due to local elevation, the St. Francois Mountains and the high plateau east of Springfield (Figure 34). The hottest area is in the southeast lowland, its temperature being due to its southerly latitude and its low altitude. From the annual isotherms Missouri is seen to have the same average temperature as most states to the eastward in the same latitude, except the Allegheny Plateau in West Virginia. So far as annual temperature is concerned it has the same as much of the Pacific Coast, but the Coast has a more even temperature, due to the oceanic influence. Missouri belongs to that large group of states having a hot summer and a cold winter.

**Winds.**—All the United States except Southern California and possibly Southern Florida lie in a system of winds whose general direction is westerly and southwesterly; in other words, the zone of the westerlies. South of us is the zone of trade winds which during the summer reach Florida and California.

**Cyclones and Anticyclones.**—Without careful observation it is not

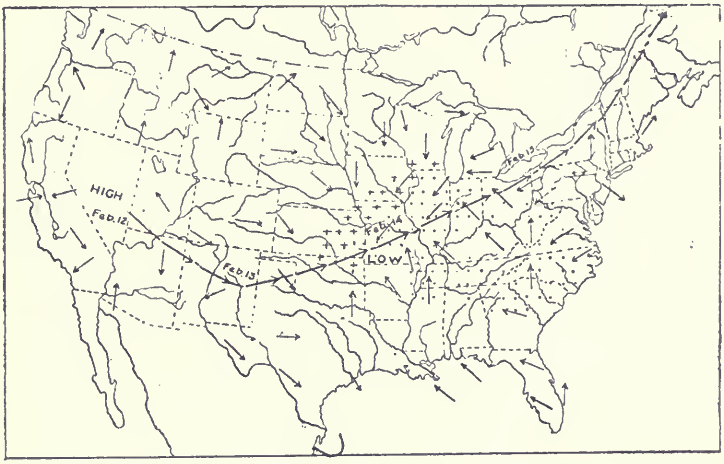

Fig. 36. Cyclone and anticyclone, Feb. 14, 1908. The heavy arrows show the path of the cyclone, Feb. 12-16, the lighter arrows, the wind directions; the dates show the successive positions of the cyclone's center. The dotted areas were rainy and cloudy; the areas indicated by crosses were regions where snow was falling on Feb. 14.

at once evident that most of our winds are westerly, since they blow from all possible directions. The reason for this variability in wind direction is to be found in the cyclones and anticyclones which are peculiar to this belt of westerly winds.

The term cyclone, properly used, means a rotating system of winds moving from west to east with the prevailing drift (Figure 36). For the violent local whirling storms to which the term is often applied, the term tornado is the better. When there is a large area of light air, the surrounding heavier air flows toward it from all direction and forces up the lighter air in the center. If the earth were not rotating, these winds would in a large measure blow straight into the low pressure area and force the lighter air up. The earth's rotation deflects southerly winds to the east and northerly winds to the west. In consequence, the winds enter the low spirally instead of straight (Figure 36).

Anticyclones have heavy air at the center which blows out in all directions toward the higher air. Here again the rotation of the earth deflects the northerly winds eastward and the southerly winds westward (Figure 36). The air movement in an anticyclone is with the hands of the clock or clockwise, while the rotation in the cyclone is counter-clockwise.

Cyclones and anticyclones are usually associated, a cyclone seldom appearing without an adjacent anticyclone. Both are hundreds of miles in diameter, a cyclone or an anticyclone not infrequently occupying all of the United States east of the Rocky Mountains.

Precipitation in the forms of rain, snow, dew and frost is always due to the cooling of air below its dew point. The air even in the droughts of our summer is well supplied with water vapor, but there is no precipitation because the vapor-bearing air does not become sufficiently cooled. Air is cooled to the point of precipitation in several ways. Most important of all is the cooling by rising. When air rises, as for example in the center of a cyclone or in passing over a mountain range, it cools in two ways: in rising the air expands and is thereby cooled, and, furthermore, it comes into contact with cooler air and is somewhat chilled. This is the origin of most of our important rains. Again a mixture of warm and cool air will often chill the former to its dew point and cause precipitation. Locally, warm, moist air passing over cool surfaces is frequently so chilled that fogs result, such as we see in spring over a river.

Our summer thunder storms illustrate these principles. They usually occur when there are no strong cyclones or anticyclones. In the afternoon the air becomes heated, rises and is chilled to its dew point and the storm slowly drifts eastward with the westerly drift, giving the familiar phenomenon of our summer rains coming from the

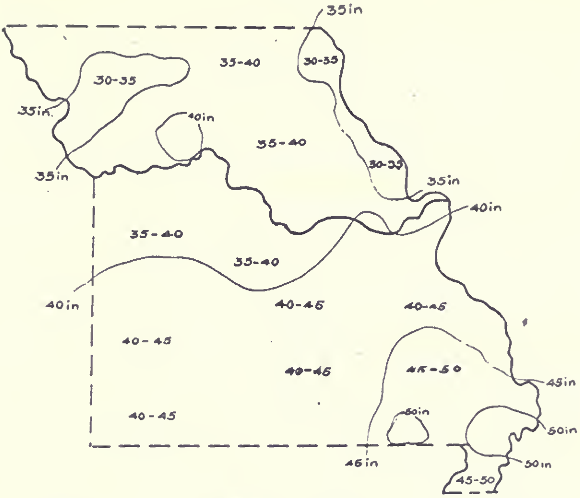

Fig. 37. Mean annual rainfall of Missouri from averages of 21 years. (after George Reeder, U. S. Weather Bureau).

west. Other thunder storms are connected with the movement of cyclones.

The average annual rainfall of Missouri as a whole is 39 inches (Figure 37). The state lies well within the humid belt of the United States. But the average rainfall, like the average temperature of a place, gives but little idea of the important factor of distribution. Some parts of California with an average annual rainfall of over 20 inches are so dry during the crop season that irrigation is necessary. For most of the United States the critical crop months are from March to August, the growing season. For most crops, a dry harvesting season is desirable. Missouri as well as most of the Plains states west of the Mississippi and east of the ninety-eighth meridian has a very favorable distribution of rainfall. The graphs in Figure 38 bring out this fact by comparing the distribution with that of the Eastern and the Pacific states.

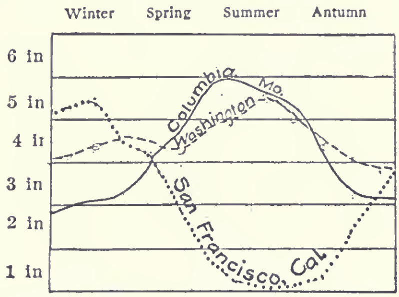

Fig. 38. Graphs showing the yearly distribution of precipitation at Columbia, Mo., Washington, D. C., and San Francisco, Cal.

The weather of most of the United States is intimately connected with cy-

clones. Were it not for cyclones and anti-cyclones, one day's weather would be much like that of another, a condition that obtains in belts of relatively constant winds as the trade wind belt. These movements during the fall, winter and spring months progress at an average rate of about 30 miles an hour and average, perhaps, two or three each week.

Each cyclone and its usually following anticyclone is a weather unit by itself. The temperature, precipitation, winds and cloudiness are in marked contrast in front of and behind the whirls. East of a cyclone the winds are easterly, the temperature relatively warm and the sky usually cloudy. West, the winds are westerly, the sky usually clear or clearing as the anticyclone follows.

In the cyclonic control the preceding principles find application. In front of a cyclone the warm southerly winds are cooling and therefore likely to yield clouds and rain or snow, especially when they rise in the center of the cyclone. These winds are, for the most part, warm, because they blow from southerly latitudes, and because the prevalent cloudiness retards radiation. Back of a cyclone the winds are cooler because they are westerly and northwesterly. They in part proceed from the cool anticyclone area and the clear skies favor radiation. Since they are becoming warmer, these winds are not liable to produce either clouds or precipitation. The cool or cold weather back of a cyclone is increased by the active radiation due to the clear skies.

It is readily seen that much of the weather of Missouri depends upon its position with respect to the average paths of the centers of cyclones and anticyclones. By far the larger number follow paths north of Missouri; the state is far to the southward of the average path and this fact in part explains the general southerly direction of our winds. Most of the whirls enter from the northwest, swing around Lake Michigan, and depart through New England or the St. Lawrence Valley. They swing farther south in winter than in summer. They are also the most numerous, strongest and best developed in winter and weakest in summer.

Our severe winter storms are usually caused by a cyclone whose path lies far south of the average paths. The storm of February 14, 1898, is typical (Figure 36). On February 12th a well-defined cyclone appeared in Nevada. As it came eastward it caused northeast-to-southeast winds in Missouri. Warm temperatures and rain occurred in Missouri and the states to the eastward, while snow fell to the northwestward. By February 15th the cyclone had moved northeastward until its center was in New York and the upper Mississippi Basin was in its western quadrants. Westerly winds, clear skies and lower temperatures prevailed during the passage of the western

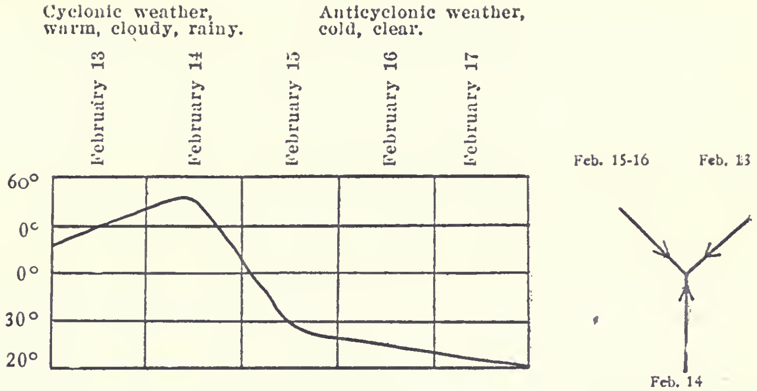

Fig. 39. Generalized weather changes in Missouri during the passage of the cyclone and anticyclone, Feb. 13-17, 1908. (Figure 36). The wind arrows at the right show the changes in wind direction.

quadrants of the cyclone and the following anticyclone. During the five days occupied by the migration of the cyclone and the anticyclone the temperatures in the state had a range of about thirty degrees. The changes during this time are shown in Figure 39.

The "cold waves" occur during the passage of cyclones. If the cyclone center passes south of us, a blizzard is likely to ensue. "Hot waves" occur typically when a sluggish cyclone to the north of us draws southerly breezes for many days. Occasionally a sluggish anticyclone moves in a southerly path and forces warm air over the northern states. Again during July and August, there are few cyclones and anticyclones. The high temperature is due largely to insolation and the absence of cooling breezes is due to a lack of or weakness of cyclones.

**Frosts.**—As a climatic factor conditioning many crops, frost is extremely important. For example, the summer temperature and rainfall of much of Missouri is favorable for cotton growing, but the frost-free season is for the state as a whole too short for the present varieties. The general conditions favoring frost are clear skies and quiet air. These conditions are best met in the anticyclonic weather of spring and autumn. But frost is largely local, depending on many factors, as the kind of soil, the altitude and the slopes. In general, valleys are more subject to frost than the adjacent hills. The cooler, heavier air of the hills flows down the hill slopes into the valleys, the warm air is displaced and is forced upward. Often the foliage on hill sides shows the usual frost line. As to frost, Missouri is about midway between the Northern and the Southern states.

Perhaps no other geographic factor is so easily and profitably

studied as climate. Even each school district has a local climate of its own; especially are frosts, dews, fogs and local rains easily studied. The United States Weather Bureau needs local data and will publish well kept observations in the Monthly Weather Review published at Washington.

## VII.—SETTLEMENT OF MISSOURI.

### EXPLORATION.

The riparian region of Missouri was early explored, first along the Mississippi and later along the Missouri and its tributaries. The easy portages between the Great Lakes and the Mississippi early led the French voyageurs down the Mississippi. The journeys of Marquette and Joliet (1673) and La Salle (1682) opened the way for the explorer and trader. At least as early as 1700 lead had been found in the Meramec Basin and lead, excepting the precious metals, was the most desirable metal for the trader (39 a). By 1703, it is a matter of record that French explorers had been guided up the Missouri, which at that time was believed to afford a passage to the Pacific (62 a), and it is probable that unrecorded voyages had been made before that time. The French were primarily traders and not settlers, and followed a fur supply that rapidly receded westward. The record of their explorations is found in the numerous place names of streams along the Mississippi and Missouri. The easy pathway, therefore, afforded by the rivers, both from the north and from the south, together with the accessible lead ore in southeast Missouri, expedited the early exploration by the French.

The census of 1790 shows a fairly dense population on the Illinois side of the flood plain of the Mississippi between St. Louis and Chester. Here the river for the most part flows along the western part of its valley, leaving a wide, fairly continuous lowland to the eastward. Accessibility, fertile and easily tilled land, and the lucrative fur trade located a zone of French settlement here and a considerable French population had settled on the Missouri side. The flood plain in the vicinity of St. Genevieve was well settled and there was a considerable commerce in salt evaporated along the Saline River and considerable quantities of bacon and flour were exported down the river to New Orleans and up the river to St. Louis. The fall of the streams flowing eastward from the Ozark border afforded water power by which the flour was manufactured. The lead region of the Ozark Center and Border was settled by both Americans and Frenchmen. Mine La Motte, Bonne Terre and other place names of towns recall the French element in the population. The lead was crudely smelted and found river transportation at St. Louis, Her-

culaneum and St. Genevieve, whence it was shipped to points along the connecting rivers, to the eastern states by way of the Ohio and to the West Indies from New Orleans. The Lewis and Clark expedition in 1804 advertised Missouri and opened the way for settlement and further exploration. From the Missouri and Mississippi a skirmish line of trappers went up the tributary valleys and opened the way for settlement. Many of the traders and trappers settled and formed nuclei around which settlements gathered.

## SETTLEMENT.

General Factors.—Like the topography and climate, the settlement of Missouri was only partially local; it was a part of a general westward movement from the East. The rise of steamboat navigation, the completion of the Erie Canal, the cessation of Indian hostilities and the large number of Europeans forced into America as a result of the Napoleonic wars, were some of the larger factors that hastened immigration westward (66 a). This migration into the Middle Mississippi Basin was largely directed by two national highways. The Mohawk pass in New York offered an easy roadway to the Great Lakes, with the result that the northern parts of the states bordering on this great highway were largely settled from New England and New York. To the southward the Ohio Valley offered a natural route from the Middle Atlantic States, and in consequence it was followed by settlers from Pennsylvania, Virginia, the Carolinas, Kentucky and Tennessee. The line of westward movement was an irregular line extending far up the valleys and bulging to the southward until with the opening of the Erie Canal and the extension of east-west railroads the line of settlements extended northwesterly.

Missouri lay across one of the principal lines of westward movement. Both the Mississippi and the Missouri valleys led away from the Ohio Valley route. Missouri was very largely settled from the states of the northern South. In 1850, of those not born in the state, 12 per cent came from Kentucky, 8 per cent from Tennessee and over 45 per cent came from the slave states. The Kanawha, Cumberland and Tennessee rivers afforded an easy exit from Kentucky and Tennessee to the Ohio. The soil and climate were not unlike those of the home states, and while many of the settlers did not own slaves, yet they were accustomed to slavery. Moreover, since by the Ordinance of 1787 slavery was excluded from the states north of the Ohio, Missouri was somewhat more congenial to settlers from the South, although it must be remembered that in 1850, when we have the earliest census statistics on nationality, over 30 per cent of Missouri's inhabitants came from northern states. The state was well known

along its main streams, since trappers and fur traders had been long at work before the Lewis and Clark expedition in 1804. Just as New Englanders found a climate and glaciated topography familiar to them in the Northern Mississippi Basin, Southern settlers found institutions, climate, and, in some degree, soils to which they were accustomed.

**Settlement of the Physiographic Provinces.**—The Alluvial and Loess Belt was naturally early settled, although the lead regions of the Ozark Border and Center were early explored and thinly settled. However, like most mining settlements, the latter regions were not sought by home seekers and their population was somewhat transient. By 1810 the Mississippi Flood Plain below St. Louis was settled by an agricultural population and a line of settlement extended back about 50 miles from the river (14 a). The settlement, however, did not move steadily up the alluvial lowland, but leaped from St. Louis to the famous "Boone's Lick Country," where the flood plain and Loess Belt widens and graded valleys extend far to the northward. The flood plain from St. Louis northward along the Mississippi is largely on the Illinois side. The settlement along the Missouri extended in a dense zone by 1830 to the Platte Region which was yet in control of Indians (Figure 40).

There were many reasons for this early settlement along the alluvial lowlands and adjacent loess belt. They were easily reached by boat and the river afforded an easy journey to markets. The soil on the natural levee along the river is a sandy loam, easily tilled and fertile. Water supply and timber were at hand. The settlement of the prairies was deferred in most of the prairie states until the bottom lands had been taken up. There was a widespread misadaptation due to the fact that the immigrants from the East were unused to prairies (12 a). The prairies were exposed to the sweep of the winds and were considered bleak and inhospitable in winter. There were few springs, and water for man and beast was not always easy to obtain. In many instances the first cisterns were unsuccessful wells that were allowed to fill with rain water. The relatively impervious clay held the water and furnished a cheap cistern. The soil was very tough and difficult to plough with the implements then in use. The prairies were for the most part devoid of timber and this was considered as an indication of infertility, for the better lands in the East were timbered. Moreover, the timber was needed for fuel, fences and cabins. The flood plain soils were timbered, easily available and the herbage of the moist areas remained green through the winter and afforded winter pasturage (14 b). The discovery of the fertility of prairie soil was largely accidental and for nearly a generation the prejudice persisted.

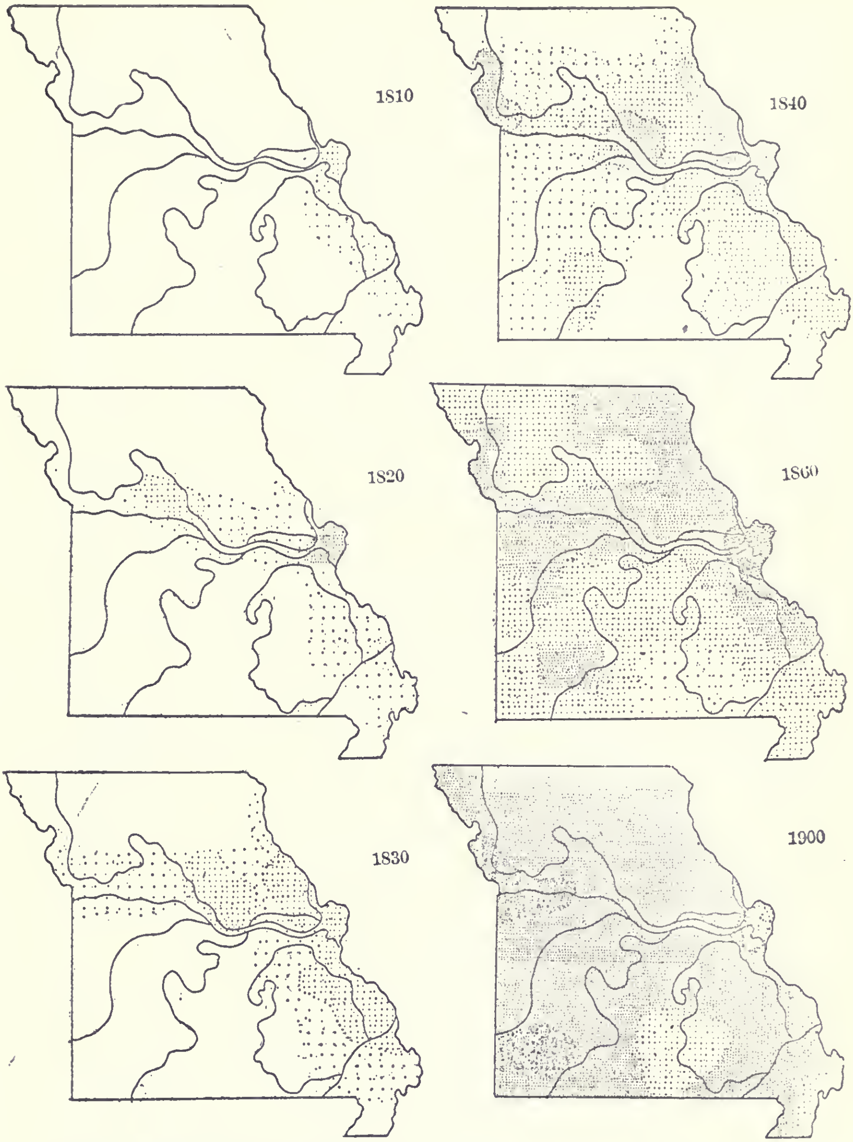

Fig. 40. Population per square miles of Missouri at different decades in the different Physiographic divisions.

There were many disadvantages associated with life on the flood plain. Portions are subject to yearly floods and every few years practically all the lowland is under water during the June floods. Buildings, fuel, fences and stock were swept away. After each flood there was usually an epidemic of malaria or "river fever." Portions of the flood plain enclosed between the bluffs and the river often were social units and were settled by relatives or former acquaintances. After a flood an entire community would often emigrate elsewhere, frequently to the prairie.

It was fortunate that the wide flood plain in the Boone's Lick country was bordered by the wide loess belt. When because of the floods, the malaria or the pressure of incoming immigration, the flood plain settlers moved on, they found near at hand the loamy loess, which, in contrast to the prairies, was well drained and its soil was much more easily tilled than the heavy clay of the adjacent prairies. The movement to the loess belt was not sudden, as a whole, and was presaged by the use of that belt for summer pasturage. The early and dense settlement in the Boone's Lick country was perhaps accelerated by salt springs which afforded this useful commodity and gave the name to the region.

The population maps show that the dense population rapidly extended along this belt up the Missouri in marked contrast to the less rapid growth along the flood plains of the Mississippi below St. Louis. It is an interesting fact that during the latter part of the slavery period the slave population was most dense on the flood plain and loess belt of the Boone's Lick country (Figure 41).

**The Ozarks.**—The entire Ozark region was explored earlier than the prairies. The mineral deposits in the eastern part tempted further explorations to the westward. It is not improbable that De Soto penetrated the southeastern Ozarks in his fruitless search for gold. The more advanced dissection of this region gave numerous valleys and streams, many of them navigable, which guided traders, hunters and explorers up to the top of the Ozark dome, whence tributaries of the White River led westward. Then again the more numerous water courses and the larger forested areas along them afforded haunts for numerous fur-bearing animals. Hence a very sparse hunting population was rather early distributed over the Central Ozarks.

**The Ozark Border.**—The settlement of the eastern border has been mentioned and was largely agricultural. The limestone belts of the eastern border and the nearly graded lower parts of the valleys gave fertile soils. Mill sites along the upper courses of the streams were abundant and there was a good market for flour down the river. A considerable part of the lead mining was done by farmers who owned the land and gathered the ore during the winter and at times

when they were not otherwise employed. The early settlers were largely French, but Americans soon outnumbered them. By 1820 a considerable colony of Germans was in the Cape Girardeau district (10 a), where many of their descendants still remain.

The further permanent settlement of the Ozark Border did not, as might perhaps be expected, extend westward from the densely settled eastern part, but began in the southwestern portion in the Springfield region. Early settlers entered this part by way of the White River which, together with its master stream, the Arkansas, was navigable. Light draught steamboats early came up the White River into this region. This area, moreover, was the focus of several well traveled routes. Here crossed roads from the southwest to Boonville on the Missouri and to St. Louis, the latter road pursuing the well-defined divide now in large part followed by the Frisco Railroad. Another feature that attracted the settler from the mountainous districts of Kentucky, Tennessee and adjacent states, was the many excellent springs. They gave a widely current appellation to all southwest Missouri, which was known as "The Boils," often corrupted to "The Bulls." But the feature that led to the rapidly increasing density of population here from 1840 to 1860 was the excellent agricultural possibilities. Here the Border is wide and generally prairie like. The soils are fertile and easily tilled and there was a fair market, although the expense of getting bacon, cattle and flour to the river

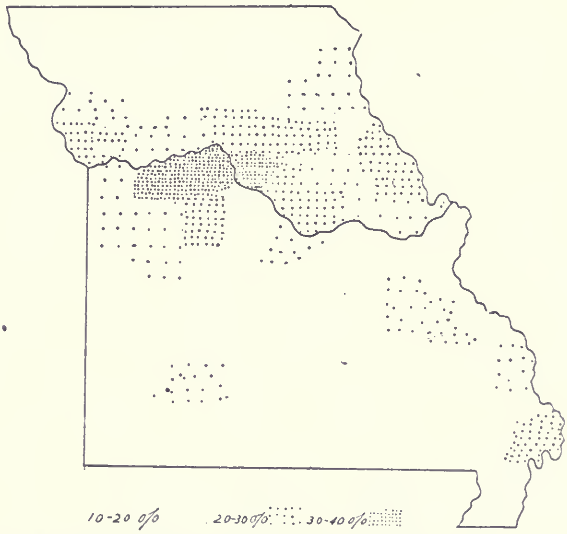

Fig. 41. Map showing the distribution of slaves in 1860.

for transportation was heavy. Cotton was grown for local use, but was often cut down by the frosts. The settlers from Kentucky and Tennessee brought their habits of hemp culture which continued until war times. The southwestern border sent much of its products overland to river towns to supply the Santa Fe trade.

An especially dense population in the southwestern part of the Border is due to the mining of zinc and lead. About 1849 lead was discovered near Joplin, but it was not until over twenty years later that mining was actively begun here (39 b). At first the zinc was thrown away. Previous to about 1880 the lead was transported for shipment to river points, such as Linn Creek on the Osage, Boonville on the Missouri and Fayetteville on the Arkansas (39 c). About that time three railroads reached this area and mining received a new impetus. The area has been very productive. The large mining population furnishes a good market for the farm products of the surrounding region in the Ozark Border, the Old Prairie and the Ozark Plateau.

A particularly interesting incident in the settlement of the narrow part of the northern Ozark Border was the Hermann settlement (56). The German Settlement Society of Philadelphia in 1837 founded a German colony here. The instructions to the commissioners who located the colony were, among other things, to search in Illinois, Indiana, Missouri, Wisconsin and Michigan for a region of good agricultural possibilities on a navigable river where a large city might grow. The site of the hoped for emporium was chosen near the confluence of the Gasconade and Missouri, a situation possibly suggested by the confluence of the Schuykill and Delaware at Philadelphia, the home of the society. It was hoped that the iron and lead region might, upon further prospecting, be found to extend into the purchase. It was noted that the land, although hilly, was suitable for pasturage, fruit, and for grapes, that the soil was derived from limestones, and that there were abundant springs. Soon a German colony of several hundred was located. Dissensions soon broke out, the colony was dissolved in 1839 and Hermann did not become a rival of St. Louis. Nevertheless, by their industry and frugality, the Germans and their descendants have become highly prosperous in a moderately dissected region and from a soil only moderately fertile, a soil indeed that in some parts of the Border would be largely given over to pasture.

**The Ozark Center and Plateau.**—Here again the presence of easily obtained lead ore led to early settlement in the lead region. There was a settlement in Mine a Breton (Potosi) as early as 1775 (62 b), the Murphy Settlement (Farmington) was made in 1798 and Fredericktown in 1800 (47 i). The crudely smelted lead was valuable

enough to allow pack horse transportation to the Mississippi or boat carriage down the Meramec. The rich iron ores in Iron County early attracted attention, and furnaces were erected as early as 1815 near Pilot Knob, for which the abundant timber furnished charcoal (62 d). This industry grew until the middle of the nineteenth century and the hopes of developing the supposed extensive iron ores directed one of the earliest railroads (Iron Mountain) to this area. The forests of the Center and especially the pine forests of the southern part of the Plateau yielded considerable merchantable timber. Saw mills were in operation and timber was rafted down the Gasconade by 1832 (60 a). The Ozark Plateau with its timber growth, its dissected topography and its climate in many ways resembled the Cumberland Plateau of Kentucky and Tennessee and the Plateau was largely settled from these states. The early settlers took up land along the flood plains in the narrow valleys and used the relatively unforested divides for pasture, much as they had done in their former environment. These provinces have been slow in settlement except in the productive lead districts, and much of the area must remain uncultivated. In the southern part of the Plateau fruit growing has been successfully developed.

**The Old Prairies.**—These were not distant from the great highway of the Missouri and were bisected by the Osage, upon which there was early flatboat navigation (15 a). An early center of settlement and trade was at Harmony on the Osage in southeastern Bates County. Here in 1821 was established a missionary station by a Boston society and this served as a nucleus for settlements. As elsewhere, the open prairies were at first avoided and settlers chose the timbered belts along the streams. As late as 1852 the prairies were held in light esteem. However, the Indian trade to the southwest and the Santa Fe trade gave good markets for flour, bacon and oxen, and the country was rapidly settled between 1840 and 1860. Cotton was grown for home use but, as elsewhere, it was an unreliable crop owing to the frosts.

**The Glacial Prairies.**—These prairies were rather slowly settled in view of their great productiveness. In the great rush to Boone's Lick Country the southeastern prairie was on the line of the main road and by 1820 settlement had been well begun between St. Louis and the Boone's Lick area, although it required more than two decades for this part of the prairie to reach the density of the Boone's Lick region 70a. The hilly, rolling land parallel to the Mississippi was next settled. Easy communication by the river was one factor in this settlement. The same prejudice in favor of hilly or rolling land prevailed here as elsewhere and, moreover, from the records obtainable it appears that a considerable area in this belt, even on

the prairie, was timbered and timber always appealed to the eastern emigrant. A good market for the northeastern counties was found in the Wisconsin-Illinois lead region (15 b).

Bek, who in 1823 wrote a widely read Gazetteer of Missouri, lent his influence to the prejudice against the prairie, stating that "Prairies must for long time remain wild or uncultivated." Flint, who for some time resided near St. Charles reflected this general opinion when he stated that the prairies are "generally too destitute of wood to become habitable by any people other than hunters and shepherds" (11 b).

During the "Mormon war" in 1836, in the northwest, it was proposed to allow the Mormons and Indians to occupy the flat divides on the ground that they were "good only for Mormons and Indians." Hence it was that the skirmish line of settlements extended in narrow belts along the timbered valleys. It took more than a generation's experiences to find the value of prairie soils. Indeed many elderly men can well remember this idea which they themselves have scarcely yet overcome. The prairie, distant from the large rivers, lacked easy transportation and it was not until the completion of the Hannibal and St. Joseph railroad that the rapid settlement began. Before that time settlement had moved into the prairie from the rivers in the east, south and west.

The growth of the different physiographic divisions is brought out in the graphs of Figures 42 and 43. The rapid settlement of the Ozark Border, the New Prairie, the Loess Alluvial Belt and the Old Prairie continued until about 1880 and have decreased since 1900. The Ozark Center and Plateau have been more sparsely and slowly settled and their population is still gaining, but more slowly than before 1880. The lowlands slowly gained in population up to 1890 and their rapid increase since then is in mark-

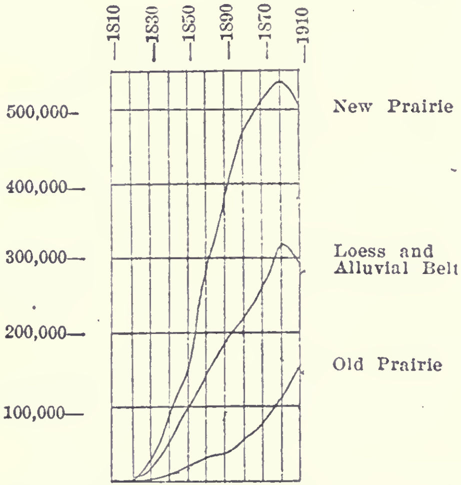

Figure 42. Graphs showing the growth of population in the New (Glacial) Prairie, the Loess and Alluvial Belt and the Old Prairie.

ed contrast to that of the other provinces. Until the available lands surrounding them had been occupied, settlers did not occupy the lowlands, where expensive drainage was necessary. This area is now having the boom that was experienced a generation ago in the other provinces.

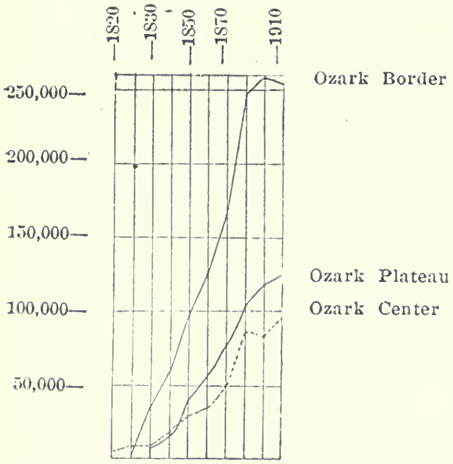

Fig. 43. Graphs showing the growth of population in the Ozark provinces.

## DEVELOPMENT OF CITIES.

While cities and towns accompany settlements, they present different problems from a geographic point of view and are therefore considered separately from the settlement of the different physiographic provinces. A city will develop wherever population is concentrated by trade, manufacturing, or otherwise.

Political Towns.—These grew up about administrative centers. Jefferson City was placed west of the center of population at that time and near the geographical center of the state. Its growth has been almost entirely due to its position as the state capital. It has a limited hinterland and but for its political advantage would probably not have attained its present size. St. Louis and Cape Girardeau are examples of towns whose growth was accelerated by their position as military posts. In later paragraphs it will be seen that many towns and cities in Missouri owe much to their position as political centers.

**Industrial centers** may develop in a region of distinctive industry or in a territory with varied needs. Joplin grew to supply a center connected with the mining of lead and zinc. St. Louis, with its varied manufactures, has no especially distinctive industry, since its hinterland has varied products and needs.

**Commercial centers.**—Such centers grow where the trade of an area is concentrated and such concentration is almost invaribly due to a meeting of routes. At such a convergence the commerce and

manufactures for the tributary area or hinterland are focused and carried on at maximum advantage. Here is the meeting place of raw materials and factory, the distribution of materials and the concentration of capital.

For such a focussing of routes English geographers have suggested the term **nodality.** St. Louis owes its early growth to its favorable river nodality. Springfield's growth was due to a nodality caused by the crossing of natural overland routes. Warsaw and Tuscumbia were ferry towns where land routes crossed the Osage and afforded a combination of land and river nodality. Artificial nodality is created by the meeting of railroads or canals and is to be associated with those means of communication. A very pretty instance of shifting nodality was seen when the Missouri Pacific was building. The construction just preceding the Civil War was not steady, but intermittent. The railroad reached Tipton, and this town remained the terminus for a year. Here concentrated the mail and trade routes to the southwest and high hopes of a future metropolis were aroused. The next year the railroad was extended to Otterville, and this in turn became the center of trade, many houses being moved from Tipton. Smithton was the next terminus and finally the railroad reached Sedalia, where further construction was delayed by the war. Here the terminus remained for several years. Besides being a commercial center, Sedalia was the shipping point for vast quantities of military stores used in the military movements of that locality. Moreover, Sedalia was located in a fertile, rapidly settling prairie region and by the time the railroad was built westward Sedalia had secured a momentum which she was able to hold. Later the railroad machine shops were located here and the importance of the town directed other railroads hither, so that Sedalia is an important railroad junction point.

**Distributing Towns.**—If in a considerable area the distribution of population, products and commercial facilities were precisely equal throughout, it could readily be imagined that at equi-distances of say ten to twenty miles, distributing centers would spring up. At these centers the produce of the local hinterland would be marketed, local factories and retail stores would be provided to meet the local demands, and banking facilities would be established. In some parts of Missouri, especially in the uniform Prairies and Mississippi Lowlands, such an ideal arrangement of distributing centers is closely approximated. It was a generally observed rule to locate the county seat near the center of the county so it would be easily accessible from all parts of the county. These political centers, in the absence of towns with greater geographic advantages, became the chief dis-

tributing centers of the counties and have frequently become important cities. When railroads were built, if the county seat was not reached, it was frequently changed to a position on the railroad.

**Railroad Towns.**—Railroads in large measure took the place of the rivers as lines of trade. Cities like Mexico and Moberly grew up at railroad junctions. The location of railroad machine shops, as in the case of De Soto, has been an important factor. The site of Slater in Saline County in 1875 was a corn field, when it was made a division point on the Chicago and Alton Railroad. In a few years it has become a small city.

It is seldom, of course, that any one factor is solely responsible for the growth of a town. Different factors may be in operation at different times. One factor may be predominant at one time and quite another at a later time. A city's growth is always due to a complex of factors of which the geographic factor is only one. A study and analysis of the growth of one's own town is always interesting and is well worth doing both for education and for information. Much can be done in the schools along this line and the study of one's own town will pave the way for the understanding of the great cities of the world. Furthermore, these studies should be printed in state educational journals, and local papers are usually glad to print local studies. It is only by such means that an adequate geography of Missouri can ever be written.

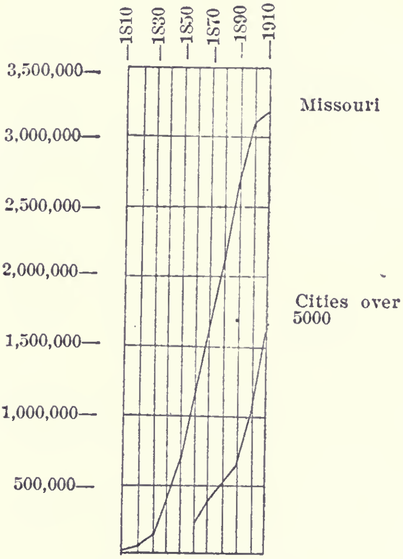

Fig. 44. Graphs showing the increase of population of Missouri and of cities of over 5000 population.

The foregoing principles will be briefly applied to some of the larger cities of the state and to some of the more notable geographic movements affecting city growth. The problems of the cities and towns have become especially interesting in view of the fact that a large percentage of our pop-

ulation is urban and the last two censuses show the movement to the cities to have been especially rapid (Figure 44).

Since the alluvial belt was early and densely settled, naturally we find here the earliest important towns. Reflecting the prevailing industry, these towns often were first trading posts established to handle the fur trade. As the fur trade receded westward and the fertile flood plain was settled, these towns became trading points for the adjacent region.

The growth of Ste. Genevieve is typical of many of these towns. It is probably the oldest town in Missouri. It was an early shipping port for the salt made in the adjacent Ozark Border and by 1735 was a port for lead shipments from the Ozark Center and Border to the westward (13a), (71a). Ste. Genevieve became an important shipping point for the corn and wheat that were produced in the adjacent flood plain. It was a competitor of St. Louis as late as 1820 (71 c). Prior to the completion of the Iron Mountain railroad, Ste. Genevieve was a shipping point for the smelted iron of the Ozark center. At Ste. Genevieve and Herculaneum the lead was in part manufactured into shot, the bluffs here offering good facilities for shot towers which were early located here.

Geographic factors were influential in the growth of New Madrid. A low ridge, locally called "The Big Prairie" crosses the Mississippi at this point (Figure 21). This ridge leading northward offered a dry road which was an important Indian trail and afterward became an important road connecting New Madrid with Ste. Genevieve and St. Louis (62 e). Big Prairie and other less pronounced ridges in the vicinity were generally treeless and arable. A wide "slough," the Bayou St. John, joined the Mississippi here and afforded a harbor for the light draft vessels engaged in the Ohio-Mississippi traffic (11 c). In 1826, Flint records that one hundred boats could be counted on the bayou (10 b).

This favorable site was occupied by a Delaware Indian village and several other Indian villages were in the vicinity. The extensive marshes and sluggish streams furnished a favorable habitat for fur-bearing animals and a fur trading post was early established by French traders from Kaskaskia (62 e). Many flatboats coming down the Ohio with cargoes would discharge at New Madrid rather than attempt the difficult journey up the Mississippi. In consequence of these favorable factors, New Madrid rapidly grew in importance and with Natchez became the most important port between St. Louis and New Orleans (11 a). About 1790 American farmers began to settle in the vicinity and the exports of corn of 6,000 bushels in 1794 had

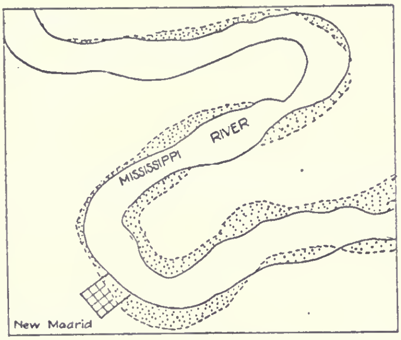

Fig. 45. The New Madrid bend. The dotted areas show where the banks were eroded from 1883 to 1902. (Mo. River Commission).

trebled by 1796 (67a). But the importance of New Madrid rapidly dwindled. Its position on the outside of a meander (Figure 45) subjected the site to constant erosion and the town has been moved away from the river several times (14 b). Indeed, were it not for the continuation of the Big Prairie across the river a cut off would undoubtedly have long ago occurred and New Madrid would be deserted. The earthquakes of 1811-12 almost depopulated the adjacent lowland and it has only rather recently recovered.

The Cape Girardeau district was largely settled by Americans, although a German settlement was located along the White Water River as early as 1799 (62 f). Early in the nineteenth century the town on the bluffs was founded and an administrative post was established from which a considerable Indian trade was carried on. The flood plain in front of the town was productive and exports of corn, wheat, tobacco, stock and cotton were important. The town was not on the river and had no especial advantage as a local commercial center and when the county seat was moved to Jackson, Cape Girardeau lost its early importance.

Together with the adjoining country, the river towns north of St. Louis were slow in developing. Hannibal, at the confluence of Bear Creek and the Mississippi, was an important trade center for the northeastern counties, but its growth to a city began with the completion of the Hannibal and St. Joseph Railroad. Louisiana, also at a confluence of a creek valley with that of the Mississippi, was an important trading point.

With the rapid settlement of the Boone's Lick Country came the demand for a trade center, and with singularly poor judgment the town to meet this demand was Franklin, situated in the flood plain opposite the present town of Boonville. Franklin was founded in 1817 and at once became the distributing point for the Boone's Lick Country. The town in its short career was the prototype of Kansas City. In five years it became the starting point of the great Santa Fe trade (58 b). It was the western point for immigrants from which they could look over possible places for settlement.

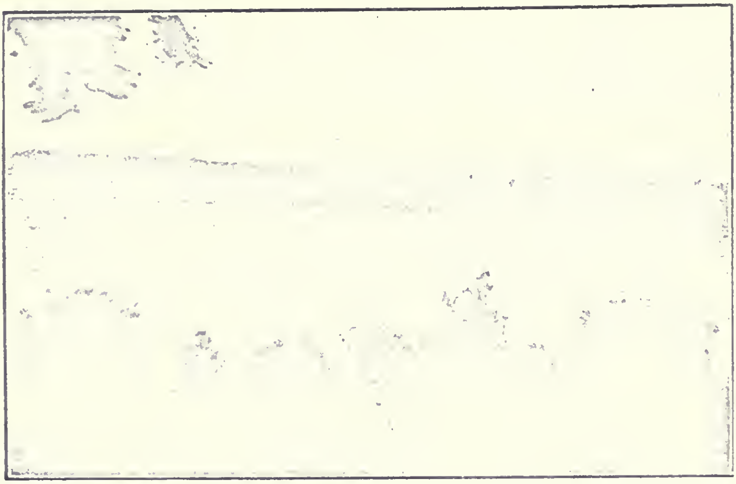

Fig. 46. Looking from Boonville across the Missouri toward the site of Old Franklin. The sand bars in the middle ground are a part of the old site.

But Franklin, situated at the river's bank on the flood plain, within nine years after its founding, began to see its site eroded and by 1832 its site was virtually abandoned (Figure 46). The inhabitants, often moving their buildings with them, went to the bluffs and founded New Franklin or crossed the river to Boonville (70 b). This town on the bluff, where, as Wetmore pompously expressed it, the Missouri's "proud waves shall be stayed," succeeded to the Santa Fe trade, and to much of Franklin's importance. The growth of towns along the river kept pace with the rapid extension of settlement along the flood plain and loess belt. Providence, Rocheport, Glasgow, Brunswick, Lexington, Westport and many others sprang up between 1820 and 1840.

In the early river towns we see a common misadaptation of site to the habits of graded rivers. It is true that the towns along the rivers in the east were subject to floods, but the rivers there, as a rule, do not have the habit of strong lateral erosion characteristic of graded streams.

Ste. Genevieve was first located on the flood plain about three miles below the present town, but by 1784 the frequent floods and lateral erosion drove the people to the safe site on the bluffs (62 b). At Franklin the settlers had believed that the interlacing tree roots would protect their site from erosion, but within a few years the river covered the site. Glasgow was preceded by two unsuccessful

towns in the flood plain, Chariton and Thorntonsburg, from which the people were driven by floods and the succeeding malaria. Old Brunswick was an experiment on the flood plain, but here again the people were forced to the bluff site of the present town. Many other towns suffered the same fate and are now known only by their locations on old maps.

Settlers soon learned to locate towns on the bluffs above the zone of floods or erosion. As the country developed, they located their towns where the river impinges against the bluff and, if possible, where, at the same place, a stream and valley debouches into the Missouri. Rocheport on the bluff at the confluence of Moniteau Creek had a warehouse in 1820 and became a thriving town and the center of a considerable boat building industry. Glasgow at the confluence of the Chariton and Brunswick at the confluence of the Grand and Missouri were distributing points for the basins of those tributaries. The principal confluence towns were on the north side of the Missouri, since the longer tributaries leading into the prairies were on that side. No towns of importance grew up at the confluences of the Missouri and the Gasconade or the Osage. The former river led to the thinly settled Ozark Plateau and much of the surplus products of the upper Osage found a local market or was drawn for shipment to Boonville and the towns above. Hermann was founded near the confluence of the Gasconade and Missouri that it might benefit from the river nodality. The adjacent hinterland was not productive enough to support a large distributing center and, furthermore, St. Louis was too near.

Prior to the construction of railroads paralleling it in the sixties,

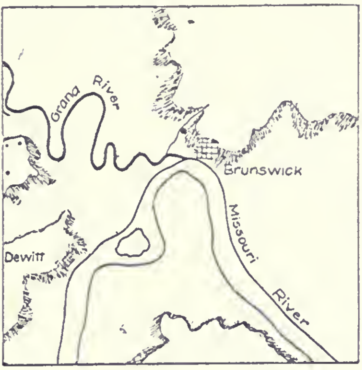

Fig. 47. Course of the Missouri near Brunswick in 1817. (after the Annual Rep't of Engineers for the Missouri River, 1881, Appendix S).

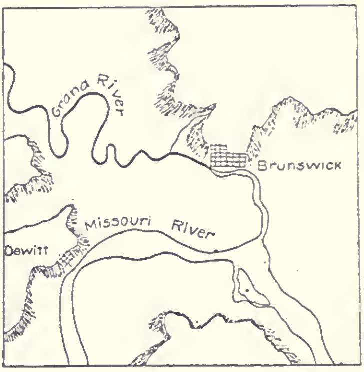

Fig. 48. The Missouri in 1887. The river has cut across the neck of the meander, leaving Brunswick several miles to the northward.

the Missouri River was an important line of commerce. The regular steamboat traffic began about 1830 and from then until the sixties scores of boats traversed the river (59 a). Important towns grew up along the stream, especially at the point of favorable nodality. With the decadence of steamboat traffic the towns lost their prosperity unless they were reached by a railroad. However, many of the towns were so important that railroad routes were made to touch them. Brunswick, although practically cut off from the river in the seventies, became a railroad junction and has retained importance (Figures 47 and 48). Lexington, Glasgow, Boonville, St. Charles and Louisiana were of such importance that railroads crossed the river at these places. An interestng result of the importance of the river zone is seen in the density of educational institutions. Of the colleges and academies in the state founded prior to 1870, but few are more than twenty miles from the Missouri or the Mississippi.

## ST. LOUIS.

**General Position.**—The area adjacent to the confluence of the Mississippi, Missouri and the Illinois must invariably contain an important trading center as the region became settled. Here was the natural focus of trade for the productive basins of the upper Mississippi and the Missouri Rivers that were, together with many of their tributaries, navigable.

The local position of the future St. Louis might be at several places, although the present site is probably the best in the area. Like so many other of our cities, St. Louis began as a trading post, and the selection of the site is due to the sagacity of Laclede Linquest. Laclede, as he is usually called, wished to establish a post for an extension of trade, of which he appears to have had the monopoly for the Missouri and part of the upper Mississippi, although this is doubted by some historians (62h). He considered several sites, among them Ste. Genevieve, then on the flood plain. St. Louis was finally chosen for several geographic reasons. Here the river, meandering in its broad flood plain, swings against the western bluff, thereby giving deep water at a site safe from lateral erosion and floods. Laclede showed his wisdom in avoiding the usual site of early towns in the flood plain, such as the logical site at the exact confluence of the two rivers. There was enough timber in the adjacent prairie to furnish fuel and building materials. Moreover, he brought from France the idea of the importance of mill sites and rightly believed that the small streams tributary to the Mississippi would furnish water power, although he probably overestimated their importance.

Founded in 1764, the post at once became important. The population was suddenly increased by the influx of French families who

migrated across the river after the cession of the country east of the Mississippi to England (72 a). It soon became an important civil and administrative post.

**River Influences.**—Prior to the steamboat area when cargoes must be light and of high value, the fur trade was dominant in St. Louis, although considerable lead found shipment from there to the south and east. Furs were used as currency nearly until statehood days and a large proportion of the population was absent during the trapping season. The agricultural possibilities of the adjacent prairie and flood plain were neglected so that frequently the breadstuffs were imported from Ste. Genevieve and other places down the river. The converging trade of the three rivers made St. Louis one of the leading fur centers (69 a) and today, long after the decline of river navigation, St. Louis is the leading center for raw furs, although the value of this industry is far exceeded by that of many others.

It was not until the development of steamboat navigation that St. Louis reaped the full value of her river nodality. The steamboat far exceeded the flatboat in capacity, speed and the ability to carry freight up stream. The "General Pike," which arrived at St. Louis in 1817, was the predecessor of a fleet that grew so rapidly that, about twenty years later, the number of steamboat arrivals was 2,050 (61 a), and the cash value of the river fur trade in 1817 amounted to $600,000, a very large sum in those days (71 b).

The steamboat carried not only the rapidly increasing fur consignments, but as the fertile flood plain and loess belt were settled, bacon, hides, flour, hemp and tobacco came to this port for transportation down the Mississippi. The city became known as a hemp, lead and tobacco center and still remains the principal tobacco manufacturing center of the United States.

As the steamboats became larger a river factor of great advantage became evident. Below the mouth of the Missouri, the depth of water in the Mississippi becomes notably greater with the combined flow of the two rivers. St. Louis was therefore the meeting place of the heavier boats of the lower Mississippi and the lighter boats of the Missouri and the upper Mississippi. Boats could run from St. Louis to New Orleans at the lowest stage of water (8 a). At such a point of transfer warehouses, mercantile establishments, manufactories, banking houses and other establishments incidental to the growing commerce were established. The Santa Fe trade had its distributing center at St. Louis. The value of the river landing was strikingly shown in 1835 when a serious depreciation in real estate occurred because the Mississippi threatened to change its channel toward the eastern bluff, a misfortune that was averted by engineering operations.

**Development.**—With such a momentum due to its river nodality, St. Louis attracted first the principal overland routes and later the railroads. By 1830 St. Louis was the western terminus of the important road from Pittsburg and of the post road from Louisville. In the fifties the Ohio and Mississippi Railroad reached the eastern bank of the river opposite St. Louis and opened railroad communication with the East. However, in the development of railroads, St. Louis was much behind her great rival, Chicago (Figure 49). This retarded development was due in part to the confidence that St. Louisans had in their geographic position which prevented greater activity in promoting railroad building (65 a). During the sixties railroad construction went on rapidly in Missouri and adjoining states and St. Louis became a center of converging eastern and western lines. Meanwhile, as elsewhere, river traffic had declined with the building of railroads. In 1871, 33 per cent of the freight handled at St. Louis came by boat, but sixteen years later the percentage was only 10 (71·d). The growing importance of St. Louis, however, as a railroad center more than offset the decline in river transportation.

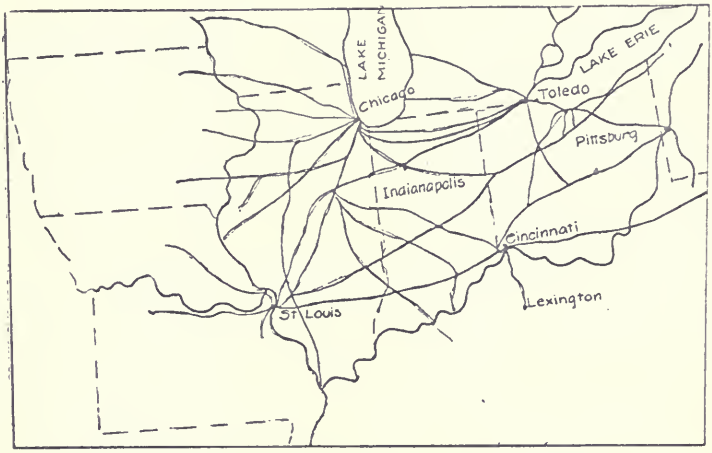

Fig. 49. Railroads in the Middle West, 1850-60 (after Coman).

During the Civil War St. Louis, with its converging railroads and southern river route, was the Federal base of supplies for the western operations and a considerable volume of business was derived therefrom and the population rapidly increased from 1860 to 1870 (Figure 50). The trade with New Orleans was shut off, with the important

result that extensive trade connections were established with the East. After the war, therefore, the business of St. Louis that had previously been largely to the southward had extended in all directions.

Today St. Louis is the emporium for the Southwest, which is its main hinterland. The varied and extensive manufactures reflect the growth and demands of a hinterland that is rapidly becoming populous and wealthy.

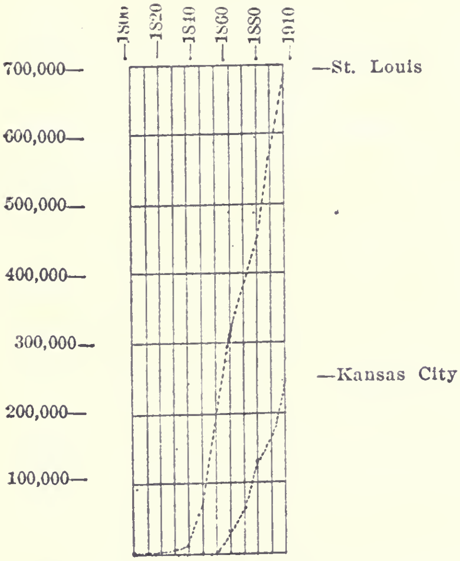

Fig. 50. Population graphs for St. Louis and Kansas City.

## KANSAS CITY.

A somewhat unique geographic factor explains much of the growth of Kansas City. The Missouri here makes an abrupt bend from a northerly to an easterly direction. Traffic for the southwest, especially for the great Santa Fe trade, left the steamboat and took the wagons and at the portage between the two modes of carriage was the place for a prosperous town.

The advantage of the site at the confluence of the Kansas and the Missouri rivers was early appreciated and in the early twenties a trading post was established here by the American Fur Company. The fur trade of the post was important during the entire river period. This nodal position, however ,offered no especial advantage over half a dozen others along the Missouri. It was only when the proper response was made to the abrupt bend of the Missouri that Kansas City had the reward of its position.

The Santa Fe trade was essentially an exchange of food, wearing apparel and general necessities for the gold, silver and pelts of the upper Rio Grande Valley. The Mexican products were of high value and small bulk and could, in consequence, bear the high cost of transportation by wagon. The high profits of one hundred to five hundred

per cent and the relatively small capital needed to equip a wagon and teams attracted hundreds of traders to the traffic.

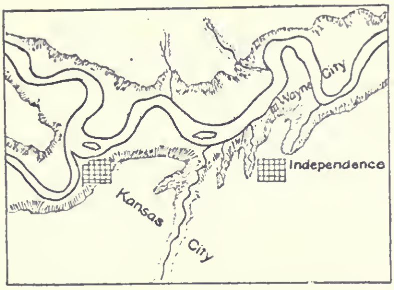

Figure 51. Vicinity of Kansas City and Independence.

The first river terminus of the Santa Fe trade was at Franklin, but in a few years its terminus had shifted up stream to Independence, nearly its logical geographical position, which was laid out about 1833 (63 a). Here the prairie extends close to the river trench (Figure 51) with ravines extending down to the flood plain. There were two landing places in the flood plain for cargoes to Independence; one at Wayne City and the other at Blue Mills, six miles below Independence (64 a). The open prairie gave facilities for deploying the long ox teams by which the wagons were moved (54). Here assembled the stores, warehouses and shops connected with the traffic and for ten years or more Independence flourished as the eastern terminus of the Santa Fe route.

There were two disadvantages that finally transferred the terminus from Independence to Westport, as Kansas City was then known. The river landings for Independence were on the flood plain and subject to overflow and erosion, and Independence was several miles from the great bend of the Missouri. Moreover, at Kansas City the river swings against the bluff, giving at once deep water and a landing secure from erosion. As competition became sharper the profitable Santa Fe trade again shifted to Kansas City, which gained the leadership shortly after the Mexican War (63 b). Kansas City remained the main eastern terminus of the great Santa Fe trade until the Civil War, although other towns, notably Independence, Leavenworth, Atchison, Omaha and St. Joseph shared in the traffic. Not only the Santa Fe route, but other important overland routes and trails centered in Kansas City and the towns along the Missouri (Figure 52).

Besides the large amounts of commodities that were handled, another factor growing out of the Santa Fe trade contributed greatly to the prosperity of Kansas City and the other towns along the Missouri. A considerable amount of metal money was brought back from Mexico and this, in the days of bank notes of variable value, gave a stability to the circulating medium and tided the people over the panic of 1857 (57 a). The entire "Border money" in 1858 was estimated to

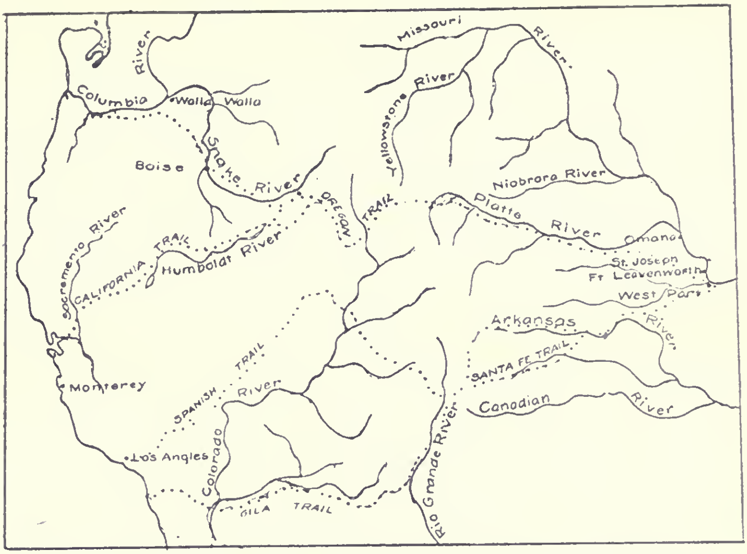

Fig. 52. Overland trails centering near Kansas City (after Semple).

amount to over $5,000,000 in value, much of which passed through Kansas City (68a). In speaking of the Santa Fe trade, it must not be overlooked that Kansas City was the center and shipping point of a fertile region that was rapidly increasing in population, exports and wealth; but the trade of this region was shared with other towns while it had almost a monopoly of the Santa Fe trade.

With the extension of railroads in the decade from 1860 to 1870 the river traffic on the Missouri declined very rapidly and the future of Kansas City lay in its ability to attract the railroads. During the war the business of Kansas City was all but suspended, while its rival, Leavenworth, was the base of Federal military operations and was prosperous. Kansas City, however, had gained such a momentum that railroads could not afford to pass it by. In 1860 the intention was to locate the western terminus of the Missouri Pacific at Independence, but in 1865 it was located at Kansas City (57 b). The Santa Fe was forced to go into Kansas City, although it was at first intended to build to Topeka (57 b). Thus it came about that Kansas City early became the principal railroad center of that part of the Missouri Basin, although it had no particular advantages for railroad construction and for a time the Missouri was more of an impediment than an aid. The last five years has seen a resumption of the river traffic at Kansas City that promises a renewal of something like its former importance.

Kansas City, Missouri, and Kansas City, Kansas, are an economic unit. Their prosperity and growth are due to the transportation facilities of so many converging railroads and to the fertile and populous hinterland tributary to them. The industries of Kansas City are not distinctive like those of Joplin or of Pittsburg, but they supply the various needs of the populous hinterland. Kansas City, together with Omaha, is near the margin of the grazing and corn belts where stock is extensively fed for the market. The beef and pork packing establishments which began in the sixties have increased until the two cities rank high in this industry.

## ST. JOSEPH.

The local position of St. Joseph resembles that of St. Louis, in that the Missouri in a broad meander swings against the east bluff whose somewhat dissected appearance gave it an early name of "Rattlesnake Hills." In the twenties Joseph Robidoux, a French trader, established a trading post here which soon became important. It became especially important with the opening of the "Platte Country" in 1836, for which St. Joseph was the most accessible shipping point. The fur trade was soon exceeded in importance by the agricultural products of the flood plain and of the fertile loess belt and St. Joseph became a noted trade center for hemp.

St. Joseph lay on the overland route to California which for a time crossed the river here. Between 1849 and 1851 thousands of emigrants crossed at this point. Moreover, a considerable portion of the Santa Fe trade centered at St. Joseph. A great impetus was given to St. Joseph when it became the terminus of the Hannibal and St. Joseph Railroad in 1859. Cheap communication was afforded with eastern markets, better prices for local products were secured, and the wealth and population of St. Joseph's hinterland as a consequence rapidly increased. By 1873 when the railroad bridge over the Missouri was completed there were three important railroads connecting the city with the East. Like other cities in the corn belt, St. Joseph has become an important center for pork packing, an industry said to have been prominent as early as 1846.

## SPRINGFIELD.

The site of Springfield offers no especial advantages over dozens of other possible sites on a broad stretch of prairie of the southwestern Ozark Border. Indeed shortly after the town was laid out in 1835, there was considerable doubt as to its permanence, since it was not at all certain that it would be the permanent county seat. But through this region ran two important convergent routes. One led from St. Louis along the divide, the "Ridge Road," and another from Boonville and other river points, both roads leading to the In-

dian Territory and Arkansas. Springfield grew on the site of an Indian village about a spring and became the focus of these important roads. In the forties there was an extensive trade in live stock and farm products to the southwest and also to Kansas City for the Santa Fe trade. The fertile prairie was rapidly settled and Springfield was its trade center. When the railroads were built the town was so important that the railroads centered there. The lead and zinc areas to the west have also become in part tributary. Springfield is an important city, a railroad center, the focus of a productive hinterland, and still retains its former trade relations with the southwest.

## VIII.—INDUSTRIES OF MISSOURI.

### AGRICULTURE.

The position of Missouri as one of the great agricultural states rests primarily on her climate, soils and topography. The climate is midway between that typical of the northern and of the southern Mississippi Basin. The rainfall is usually ample; indeed, the problem of drainage is, for the most part, more important than the problem of moisture conservation. The growing season and the frost-free season are usually long enough for the great world food staples. The summers are hot and usually moist in the early portion and dry during the harvesting season. The clays and loams of the lowlands and prairies are fertile and some are highly productive; the relatively level and undissected topography of these divisions allows extensive use of agricultural machinery.

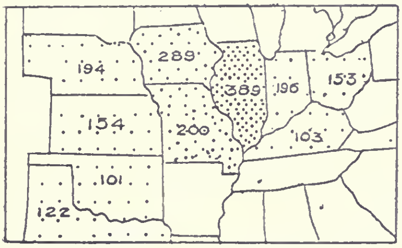

Fig. 53. The states producing 70 per cent. of the corn crop of the United States in 1909. The figures denote the production in millions of bushels.

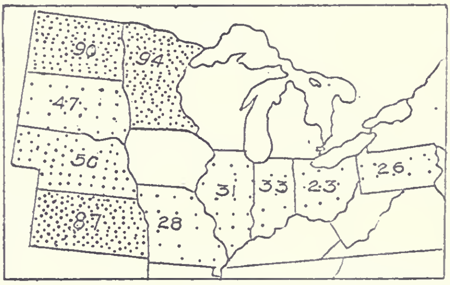

Fig. 54. The states producing 70 per cent. of the wheat crop of the United States in 1909. The figures show the production in millions of bushels.

Missouri produced in 1909 over 7 per cent of the corn crop of the United States. The position of the state in the corn belt is shown in Figure 53. The wheat crop of the state usually has about one-third the value of the corn crop. The wheat growing states and Missouri's position among them are shown in Figure 54. Large amounts of meat pro-

ducts were carried in the early river traffic and these have increased in value. Cotton has long been grown locally (11 d). It is now grown on a large scale in the southeast lowlands, mostly in Dunklin, New Madrid and Pemiscot Counties. This region with its low altitude, southerly latitude and fertile alluvial soils has a rapidly increasing acreage.

Such climates and soils place the state in the great corn belt, and this in turn accounts for the high rank of the state in swine and beef products. Corn requires a hot growing season, which excludes the crop from the great northwestern agricultural states. The climate and soils of the state are highly favorable to wheat, but wheat is an extensive crop and seeks relatively cheap land and a region not densely populated. Hence the center of wheat culture has rapidly moved westward and is now moving northwestward (Figure 55). The corn center, on the contrary, is almost stationary.

Fruit growing, especially in the lighter soils, particularly in the Ozarks, is an important and growing industry. The success of grape culture in the German colony at Hermann indicates its possibilities in other parts of the state. From the history of the older states it is safe to predict that the agriculture of Missouri will become less extensive and more intensive, especially in the more fertile portions. The average size of farms in the state in 1900 was 119 acres. These farms are capable of supporting a population many times as dense with a system of intensive agriculture.

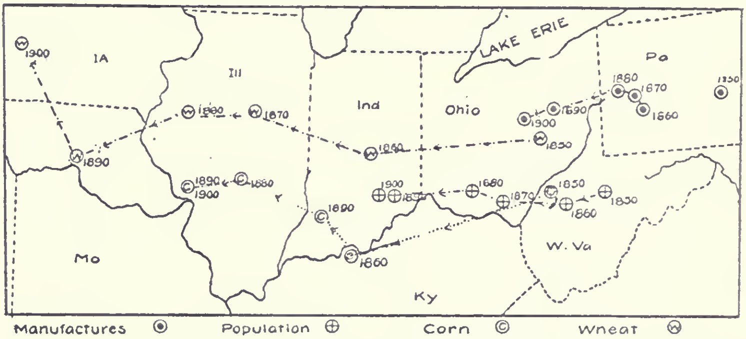

Fig. 55. Map to show the westward movement of centers of manufactures, population, corn and wheat, 1850-1900 (Statistical Atlas, U. S. Census).

The problem of drainage on the flood plains and Southeast Lowlands has been mentioned before. According to the estimates of the National Conservation Commission there are 1,920,000 acres of swamp and overflow lands in Missouri, or about 4 per cent of the entire area.

Most of this area is comparatively easily reclaimed by gravity ditches. At present the most active reclamation is in the Southeast Lowlands, but, as land becomes more valuable, the work must extend to the flood plains of the Missouri and its tributaries.

## LUMBERING.

Although Missouri is not generally thought of as a timber state, in 1908 the state produced lumber to the value of over $8,000,000, or nearly 2 per cent of the value of lumber in the United States. Most of this supply comes from the Ozarks. The growing of merchantable timber is one of the most promising industries for the more dissected portions of the Ozarks (73a). As a recognition of the present and future importance of lumbering in the state, a department of forestry has recently been established at the State University.

## MINING AND ASSOCIATED INDUSTRIES.

One might almost say that the history of Missouri began with lead mining, and the industry is still increasing in importance. We have before noted how the search for and mining of lead hastened the settlement of southeast Missouri. The importance of this industry in the state is recognized by the establishment and support at Rolla of the School of Mines.

**Lead.**—The old Mine la Motte in Madison County has yielded lead since 1720 and there are indications that the area was worked by Indians before that time. Since then the state has ranked high in the production of lead and, as regards this metal, is now the most productive state in the Union. In 1909 40 per cent of the lead of the United States, valued at over $12,000,000, was mined in Missouri. The southwestern district was opened by the discovery of lead in Jasper County in 1848 (39 d) and the district has developed rapidly.

The early mining was largely from open pits, although it was soon known that deposits lay deeper in the rocks. The open pits were soon worked out and abandoned. The diamond-drill came into use in this state in the southeastern field in 1869 (39 e). By this means deep deposits were discovered with comparative ease. Another factor that has greatly increased production, both of lead and zinc, is the use of improved machinery by which low grade ores, like the disseminated ores, can be worked cheaply. The principal uses of lead in 1909 were oxides, mostly used for paints, 38 per cent; pipe, 15.2 per cent; shot, 2.4 per cent; sheet lead, 6.7 per cent.

**Zinc.**—The history of zinc mining in Missouri compared with that of lead is recent. Active production began in the seventies when mining and reducing machinery was fairly well developed and there was

railroad transportation to market. The production rapidly increased and at present about 60 per cent of the total output of ore in the United States comes from Missouri. In 1909 the value of the zinc ore mined in the state was over $15,000,000. Comparatively little zinc is smelted in Missouri (12.7 per cent in 1909); much is smelted in Kansas and Oklahoma, where in 1909 about 60 per cent of the total zinc ore in the United States was smelted. The cheap gas of these states largely accounts for their important smelting industry. The principal uses of zinc in the United States (1909) and their percentage of use are: Galvanizing, 62.7; brass, 18.3; sheet zinc, 12.6.

**Coal.**—The extent of the coal fields in Missouri is shown in Figure 27. The beds lie approximately level and often outcrop in valleys where they are worked locally. Many farmers work these beds in the winter when farm work is slack. In 1908 Missouri produced one per cent of the total output of the United States. But a small fraction of the coal has been developed and coal lands commonly sell for their agricultural value only. The production is increasing at about the same rate as that of the United States. The value of the state's coal in 1909 was estimated at $6,591,000.

**Iron.**—The production of iron ore in Missouri at present is of relatively little importance. In 1908, about one-fourth of one per cent of the total production of ore is the United States was mined in Missouri. In 1880 the state produced 5 per cent of the ore production of the United States, but, as has been noted, the production rapidly declined with the partial exhaustion of the high grade ore of the Iron Mountain region. There is considerable good ore in the state, the mining of which must some time become an important industry.

**Barite.**—This is a heavy white mineral that is pulverized and used mainly as a pigment. Three-eighths of the total production of the United States in 1909 was obtained from Washington County with a value of about $100,000. Copper ore is mined in Fredericktown, Madison County. The glass sands of Missouri are easily mined and shipped eastward. Cheap coal and glass sand, together with good markets, have concentrated important glass plants at Crystal City and St. Louis.

## MANUFACTURES.

The manufactures of Missouri have grown because of the market, facilities for transportation, power and raw materials. Central and eastern Missouri had their development accelerated by the river routes accessible to them and we have noted the importance of these factors in preceding paragraphs. With the growth of competing railroads the river traffic has declined to almost nothing. Recently rail-

roads have been unable to handle freights quickly, railroad rates have risen and there is little doubt that a part at least of the river traffic will be resumed. The Missouri, like all graded rivers, has a shifting, shallow current which will require special boats and well trained pilots.

Railroad construction in Missouri began actively in the sixties. The first principal railroads were determined in part, not by the productiveness of the area to be served, but by the lands which were available to be given as a bonus. The construction continued until the state is now well served except in portions of the Ozarks. Railroad building in the Mississippi Lowlands has been rapid and this region is one of the most thoroughly served areas in the state. The level surface and narrow streams make construction easy in this region. The state in 1908 had 11.67 miles of railroad for each 100 square miles. In the same year the United States had 7.87 square miles.

The principal streams of Missouri are graded and do not therefore give the fall necessary for the best water power. Many smaller streams in the Ozarks have sufficient fall and some are already harnessed for use. There is an enormous amount of energy in the rapid Missouri which is unavailable by present methods, but in the French days at Cape Girardeau they used current wheels to grind their grain. This is simply a sort of wind mill placed on a raft and run by the current. It is suggestive of future possibilities along our graded rivers. There is abundance of bituminous coal in North Missouri with only a small fraction utilized.

The principal industries, as would be expected in a great agricultural state, are connected with the manufacture of meat and grain products. The rank of industries in Missouri in 1905 was: First, meat, packing and slaughtering; second, flour and gristmill products; third, tobacco; fourth, malt liquors; fifth, boots and shoes; sixth, printing and publishing; seventh, foundry and machine shop products; eighth, bakery products; ninth, lumber products; tenth, men's clothing.

The early directories of St. Louis and Kansas City show that meat packing establishments and grist mills existed from the earliest settlements. The center of the meat packing industry has migrated westward from Cincinnati until it is in the north central Mississippi Basin. In 1900 Missouri's rank in meat products was seventh in capital invested and sixth in value of products; the state ranked sixth in capital invested in the manufacture of gristmill products.

**Clay Products and Cement.**—Both of these industries have increased enormously during the last twenty years. The cheapness of production, the growing scarcity of lumber for which they are a partial substitute, and the variety of uses for which these products

can be employed are among the causes for the rapid increase in their production. The raw materials for cement and clay products are widespread, although the production of both is contingent on cheap fuel; markets, transportation and labor are perhaps more important, therefore, in these than in many other industries.

*Brick, tile and pottery* are the leading clay products. Clay for brick and tile is abundant in every county and fuel in the coal fields is easily accessible. In 1909 the state ranked seventh in clay products with an output of over 4 per cent of that of the United States. For each person in Missouri in the same year there was produced approximately two dollars' worth of clay products.

*Portland cement* is made by heating pulverized shale and limestone in the proper proportion nearly to fusion. Its rapid development in the state is shown by the fact that, starting with practically no production in 1900, Missouri produced in 1909 over 5 per cent of the total output of the United States. Four plants in 1909 produced cement valued at nearly $3,000,000. The great plants along the Mississippi near Hannibal are a partial response to the upfold of an anticline which has brought up limestone and shale where they can be conveniently quarried.

But the great bulk of Missouri's manufactories are devoted to supplying a portion of the many articles of food, clothing, implements, etc., used by a large and productive population. Manufacturers are not mobile and lag behind the growth of population. This is brought out in the map (Figue 55), which shows the center of manufactories in 1900 to be in Ohio. Ohio was formerly an agricultural state, but possessed potential reserves of coal that are now being utilized until it is now one of the important manufacturing states.

It is safe to predict that Missouri will, like Ohio, become more and more a manufacturing state. Good home markets, transportation facilities with abundant coal point to an increase in manufactures. With this, as in other cases, agriculture will become more intensive, population more dense and farms smaller.

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